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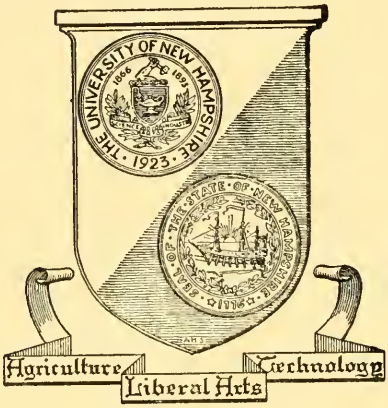

The University
of
New Hampshire

BULLETIN 354

NOVEMBER, 1944

Agricultural Research in New Hampshire

Annual Report of the Director of the
Agricultural Experiment Station
For the Year Ending
June 30, 1944

AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, N. H.

TABLE OF CONTENTS

	Page
INTRODUCTION	7
Research and War	7
Equipment	9
Gifts	9
Changes in Personnel	10
Publications	11
AGRICULTURAL ECONOMICS	12
Operation of the Agricultural Conservation Program	12
The Supply and Distribution of New Hampshire Milk	12
Feed and Egg Transportation	14
Purchasing Fertilizers	14
Recent Supply-Price Relationships for Potatoes	15
The Plan of a Small New England Town in the War and Postwar Economy	16
AGRICULTURAL ENGINEERING	16
Potato Storage Construction	16
Construction and Use of the Buck-rake	16
DAIRYING	17
Analysis of D. H. I. A. Records	17
Management Practices in University Herd	17
Chore Efficiency	18
Dry Rations for Raising Dairy Calves and Heifers	19
Improving the Solids-Not-Fat Content of Milk by Selective Breeding	20
Studies on Bovine Mastitis	21
FIELD CROPS	21
Rotation, Fertility and Cultural Experiments with Potatoes in Northern New Hampshire	21
A Dairy Farm Rotation Experiment in Southern New Hampshire with Sweet Corn as a Cash Crop	23
Producing the Full Roughage Requirements on New Hampshire Dairy Farms with Special Reference to Pastures	23
The Relation of Potash Levels to the Persistence of Clover in Hay Stands	25
Oat Variety Trials in Northern New Hampshire	26
Silage and Field Corn Trials	27
Advanced Alfalfa Nursing Trials	27

Page

FORESTRY 28
Propagation of Sugar Maples 28
Plantation Studies 31
White Pine Stands 31
Determination of the Supply of Low-Grade Wood Available for Manufacture into Plastics 31

FRUIT PRODUCTION 32
Fertilizer Elements for Fruit Trees and Leaf Scorch in Fruit Plantings 32
Winter Injury to Deciduous Fruits 32
Experiments with Blueberries 33
Root Stock Studies 33
Variety Trials 34
Breeding Work 34

INSECT CONTROL 35

ORNAMENTALS 37
The Growth of Gerbera in the Greenhouse 37
Carnation Variety Trials 37
Soil Management Experiments on Snapdragon 38
Hardiness of Ornamentals 39
Flower Breeding 39
Lily-of-the-Valley 41

PASTURES 41
Pasture Management Studies 41
Pasture Species 42
The Improvement of Ladino Clover, Red Clover, and Timothy by Selection and Breeding 42
Eradication of Common Buttercup from Permanent Pastures 43

PLANT PATHOLOGY 44
Developing Disease Resistance in Early Tomatoes 44
Spraying for Apple Scab 45
Bacterial Ring Rot of Potatoes 46

POULTRY 46
Protein Requirements of Chickens at Various Stages of Growth 46
The Cause and Prevention of Gizzard Lesions in Chickens 48
Pullorum Investigation 49
Anthelmentics in Poultry 50
Contagious Indigestion (Bluecomb) 50

Page

SOILS 51

Methods for Controlling Erosion on New Hampshire Potato Farms 51

The Influence of Soil Texture, Soil Moisture, and Soil Aeration on the Growth of Plants 51

VEGETABLE PRODUCTION 52

Factors Affecting the Storage of Squash 52

Variety Trials in Northern New Hampshire 52

Variety Trials at Durham 53

Vegetable Breeding 53

Treatment of Seeds with Hormones and Hormone-like Preparations 54

NUTRITION - VITAMINS - METABOLISM 55

Factors Affecting the Nutritive Value of New Hampshire-Grown Fruits and Vegetables 55

I. The Effects of Quick-freezing on the Vitamin Content of Strawberries 55

II. The Effects of Quick-freezing on the Vitamin Content of Red Raspberries 57

III. The Effects of Canning and Quick-freezing on the Vitamin Content of Blueberries 58

IV. The Effects of Freezing and Dehydration Upon the Carotene Content of Blue Hubbard Squash 59

The Culinary and Preserving Qualities of Fruits and Vegetables Grown in New Hampshire 60

Nutrition Studies with Lactating Cows 61

Effect of Vitamin A on the Utilization of Energy and Protein by Calves 62

Metabolism of the Horse 63

STATE SERVICE 63

Inspection of Fertilizers and Feeding Stuffs and Soil Testing 63

Seed Inspection 64

Potato Seed Certification 65

Autopsies at Poultry Laboratory 65

Pullorum Testing 65

Manufacture and Distribution of Fowl Pox Vaccine 66

Manufacture and Distribution of Fowl Laryngotracheitis Vaccine 66

National Poultry Improvement Plan 66

Dairy Bacteria and Mastitis Testing 67

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION STAFF

1944-45

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Harold C. Grinnell, Ph.D., Assistant to Dean and Director
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E. P. Campbell, Assistant to Treasurer
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Thelma Brackett, A.B., Librarian
Lurlene Gordon, B.S., Assistant in Charge, Plant and Animal Science Library

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Stanley R. Shimer, M.S., Assistant Chemist
Gordon P. Percival, M.S., Assistant Chemist
Helen J. Purinton, Ph.D., Assistant Chemist
Arthur E. Teeri, Ph.D., Assistant Chemist
Henry A. Davis, M.S., Assistant in Agricultural and Biological Chemistry

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John C. Holmes, A.B., Research Assistant in Agricultural Economics
George N. Bauer, Ph.D., Assistant in Agricultural Statistics

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Leroy J. Higgins, B.S., Assistant Agronomist
Louis T. Kardos, Ph.D., Assistant Agronomist
Betty G. Sanborn, Seed Analyst

ANIMAL HUSBANDRY

Ernest G. Ritzman, M.S., Research Professor *Emeritus* in Animal Husbandry
*Nicholas F. Colovos, M.S., Research Assistant in Animal Husbandry
*On military leave
Helen H. Latimer, Assistant in Animal Husbandry and Gas Analyst
Albert D. Littlehale, Herdsman

BACTERIOLOGY

Lawrence W. Slanetz, Ph.D., Bacteriologist
Theresa Sicilian, B.S., Graduate Assistant in Bacteriology

BOTANY

Albion R. Hodgdon, Ph.D., Plant Taxonomist
Stuart Dunn, Ph.D., Plant Physiologist
Mathias C. Richards, Ph.D., Plant Pathologist
Raymond W. Barratt, M.S., Research Assistant in Botany
Helen R. Barratt, B.S., Research Assistant in Botany

DAIRY

Kenneth S. Morrow, M.S., Dairy Husbandman
Herbert C. Moore, M.S., Assistant Dairy Husbandman
Harry A. Keener, Ph.D., Assistant Dairy Husbandman
Albert D. Littlehale, Herdsman

ENTOMOLOGY

Walter C. O'Kane, M.A., D.Sc., Entomologist
James G. Conklin, Ph.D., Associate Entomologist
Leon C. Glover, Ph.D., Research Assistant in Entomology
Wallace J. Morse, B.S., Research in Entomology

FORESTRY

Clark L. Stevens, M.F., Ph.D., Forester

HOME ECONOMICS

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HORTICULTURE

Albert F. Yeager, Ph.D., Horticulturist
L. Phelps Latimer, Ph.D., Assistant Horticulturist
Henry S. Clapp, M.S., Assistant Horticulturist
William W. Smith, Ph.D., Research Assistant in Horticulture
Winfred D. Holley, M.S., Research Assistant in Horticulture
Russell Eggert, M.S., Research Assistant in Horticulture
Raymond W. Barratt, M.S., Research Assistant in Horticulture
James Macfarlane, Greenhouse Assistant

POULTRY

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Fred E. Allen, D.V.M., Veterinarian
Ernest L. Waller, D.V.M., Poultry Pathologist
Alan C. Corbett, D.V.M., Assistant Poultry Pathologist
Richard C. Ringrose, Ph.D., Assistant Poultry Husbandman
Richard S. Ford, Assistant Technician in Poultry Husbandry
Donald A. Cross, Assistant Technician in Poultry Husbandry
Ruth E. Rinta, Assistant Laboratory Technician in Poultry Husbandry
Arline A. Nichols, Assistant Laboratory Technician in Poultry Husbandry

ASSISTANTS TO THE STAFF

Beatrice M. Richmond, Cashier
Elizabeth E. McFadden, Clerk
Theresa R. Batchelder, Mailing Clerk
Martha E. Fisher, Stenographer
Kathrina H. Legg, Stenographer
Amber H. Hall, Stenographer
Sara M. Sanborn, Stenographer
Laverna E. Murphy, Stenographer
Edith M. Smith, Stenographer
Adrienne Girard, Stenographer
Rosamond W. Raynes, Stenographer
Dorothy I. Noyes, Stenographer
Claire E. Girard, Stenographer
Bernadine E. Davis, Stenographer
Mary V. McNeill, Stenographer
Grace L. Horne, Stenographer
Margery L. Stickney, Stenographer

Research and War

BROADLY SPEAKING, there are at least three kinds of research related to war. One has to do with "secret weapons" and the improving and perfecting of the machines already in use for direct utilization in agressively hunting out and devastating the enemy. These are usually thought of as "instruments of war." Not only better guns and ammunition, improved warships, and landing craft are examples. The need of this research is obvious.

Then there is the type that concerns itself with the immediate aftermath of an engagement — better hospitals for housing, stretchers, and trucks for transporting, and medicines for treating the wounded. All this is scarcely less obvious and certainly necessary and effective.

A third kind for improvement and perfecting concerns those of us who remain at home. Fortunately the destruction of homes, the murder of women and children, and even the din of battle have not yet been visited on America. We almost seem then to "stand and wait." But it is scarcely less necessary, if possibly less obvious, to supply the daily bread for our boys at the front than to have weapons and hospitals there. Plenty of good food, well prepared, even under the most adverse conditions must be generously and regularly supplied wherever a single boy patrols his lonely post. That nothing can be more significant in the maintenance of morale is no new concept; but the production of more and better vegetable and animal products on our farms at home, the delivery of such products, often bulky and perishable, across the seven seas to millions of young men in the far corners of the earth, and to offer them, finally, in a most palatable and nutritious condition commensurate with the strenuous job in prospect, are largely new ideas.

There is a problem in production. Yes, in recognition of this need, some of the boys quite capable of bearing arms are asked to remain on the farm to help insure a continuous and adequate supply at the source. But beyond that is the greater problem of transportation involving the processing and packaging of foodstuffs for preservation through changing climates enroute, and for the endurance of the heat of a final destination in the southern Pacific or the cold of a climate like that of Greenland.

Thus, our Station, one of many research organizations studying agricultural and related prblems, seeks diligently to perform some parts of these various food problems which may contribute to the winning of the war and the hastening of an early peace. For example, in our animal nutrition studies, with some control of vitamins, we have been able to make satisfactory progress in growing cattle on rations entirely lacking in animal sources of protein. This was aimed at averting a disaster threatened by a protein shortage for livestock feeding. Even after the war, indicated results may be revolutionary and significant in the economics of feeding.

Likewise, in human nutrition we have contributed to a nation-wide project by using our native fruits and vegetables in a study of the relationship of various processes of preservation to the resulting vitamin content. These are fundamental problems for the future but results are avidly sought, currently, by the commissary personnel of the Army.

Considerable emphasis has been brought to bear through our Department of Entomology in correlating the use of new chemical products with the control of insects. The aim is to protect man and his food from the ravages of insects. This menace to our far-flung battle lines may be little realized by civilians. There is not only the disagreeable presence of biting insects to be guarded against in one's clothing and immediate surroundings, or the ever present threat to stored food and packaged rations, but also the much more serious menace from prevalent diseases in a new environment where natural immunity affords our soldiers no protection. Truly wonderful results have been accomplished and more are in prospect, making life more endurable for our service men through the use of better insect killers and repellents. We ar happy to have a part in this protective work. Some of the recent findings will be of inestimable value in postwar comfort and sanitation in our own country.

Another type of research might be exemplified by efforts in agronomy and agricultural economics to determine the most efficient and practical methods of providing more and better pasturage through brush removal, fertilizing, reseeding, etc. Nature is a prolific producer of weedy bushes and shrubs in our state. Unless we take better measures for rejuvenation and maintenance of our pasture acres the continuing deterioration will soon be extremely serious. Historically, a decline in pasture demand has tended to make a diminishing supply less conspicuous for a period of years. Now, the lessening supply is fast encroaching upon a more stablized demand.

This project is related to the war effort both directly, by providing against shortages for the duration, and more particularly, by having some answers ready for those who may ask: What can be done in farm improvement when more labor is available following the war?

In anticipation of a need to conserve rubber and gas and in co-operation with the Office of Defense Transportation, we have continued to make a study of the problems of transportation, particularly in relation to fluid milk from farm to processor. In one case, plans of the middle Connecticut milkshed have been evolved in re-routing and in co-operation which will save nearly half the mileage and half the number of vehicles. In addition, one-third of the number of "self-haulers" would travel one-fifth the distance and the whole job would be completed every day as before.

From our scores of projects, many other examples could be enumerated to prove our sensitiveness to the war needs. Many of our projects would less conspicuously relate to the war or even to postwar conditions, but would continue to contribute to morale among the producers or serve as an inspiration to those who might otherwise become discouraged by seemingly insurmountable difficulties with diseases or other threats to the success with crops and animals.

Much of our service work which helps to protect farmers against unscrupulous salesmen and poor products for feeding, fertilizer, and seeding becomes doubly significant in times when the sources of farm supply may be limited. Also the work in disease control through autopsies, pullorum testing of more than a million units of poultry, and sanitary help with the production of good milk is certainly no less important in these times of labor shortage and necessary increased production.

Additional Station equipment, not only in the laboratory for more production with less man labor on Campus, but also in the field, has enabled

our plot work to continue in spite of the shortages of labor and professional personnel and has often helped many farmers, through demonstration or inspiration, to organize their own jobs in a more efficient way.

EQUIPMENT

The purchase of new equipment, during the year, has largely been a matter of replacements and repairs. However, a few significant items which add to the efficiency and accuracy of experimental work, more particularly those concerned with those projects directly related to the war effort, have been made possible.

A new hay baler and tractor were purchased for the University Farm, and have proved to be valuable labor savers in the harvesting of high-quality hay on time. For experimental purposes, arrangements were made to use the baler on other farms on occasion. For our Department of Agronomy a 13-foot weeder and 6-foot harrow (18 discs) were provided. The Department of Horticulture replaced one of its small commercial units with a large home-freezer unit, constructed for investigating the costs of freezing and the storage qualities of home-grown fruits and vegetables. A special micromax automatic temperature recorder has been installed and is now being used in connection with measuring winter injury of orchard fruit trees. This apparatus is adapted to any work in which the accurate measurement and recording of a series of temperatures is necessary. The Department of Agricultural and Biological Chemistry purchased a steam sterilizer (autoclave). Additional motor-stirring equipment for improving the accuracy and efficiency of thiamin and riboflavin determinations has been added in this department. The many determinations required for proper sampling of selected fruits and vegetables, both in the raw and preserved stages, makes such equipment indispensable. To approximate the high pressures used for spraying under orchard conditions, the Department of Entomology has acquired a power sprayer (junior Duplex pump with regulator) adapted to attaining high pressures for inside laboratory work. This department has also purchased a motor-driven ball mill for laboratory preparation of insecticidal dusts, and a new laboratory balance adaptable for quick weighing at an accuracy to within two milligrams. The Department of Agricultural Economics has bought a scriber and templates to facilitate lettering the numerous charts and graphs prepared by the members of that department.

GIFTS

In recent months, it has been the very good fortune of the University and Agricultural Experiment Station to receive two interesting and valuable gifts. Something more than 50 years ago the late S. Albert Shaw of Hampton became interested in collecting birds and insects. For the remainder of a long life he collected assiduously. He died April 8, 1944, at the age of 87, and soon afterwards, his insect collection was received by the University as a gift. Dr. Conklin of this Station has now catalogued the collection and reports a total of 4389 specimens, virtually all of which have been identified by specialists. The collection is largely made up of *Diptera* (two-winged flies), 3988 specimens, among which are 63 families,

440 genera, 105 species, and a total of 401 specimens of *Hymenoptera,* predominantly wasps.

This valuable collection will be labeled and housed with the Experiment Station and state collections. This representative group of New Hampshire *Diptera* should prove to be of considerable value to the departmental staff and of great interest to other collectors.

Dr. Shaw's bird collection is housed at the Hampton Center school and his collection of moths and butterflies is in the possession of Dr. William Proctor, Mount Desert Island, Maine. Mr. Shaw is credited with having made the first collection of browntail moths in New Hampshire. Additional specimens of *Diptera* collected by Mr. Shaw are to be found at the United States National Museum in Washington and also at the Museum of Natural History in Boston.

In January, 1943, 594 mounted herbarium specimens, mostly of flowering plants, were presented to the University by Mr. and Mrs. Charles W. T. Willson of Farmington, New Hampshire. This gift is in honor of their son, Charles Edward, who was killed in action aboard the aircraft carrier Lexington in the battle of the Coral Sea.

This fine collection makes a valuable addition to the University Herbarium which is being used increasingly, as it enlarges and becomes more representative of our flora. Requests for the identification of weeds and economically important plants are frequent.

CHANGES IN PERSONNEL

In administration John H. Baker, Assistant to the Treasurer, resigned February 29, 1944. The Station part of his work was assumed by E. Prescott Campbell, Purchasing Agent.

Miss Camilla Romstad, Publications Editor, resigned August 31, 1943. Mrs. Ella S. Bowles was appointed October 14, 1943, temporarily, to assist in editorial work and later became University Editor.

Miss Dean Hosken, Research Assistant in Agricultural Economics, resigned July 31, 1943, to accept a fellowship at Northeastern University. Dr. George N. Bauer, Professor Emeritus in Mathematics, was secured for a temporary appointment to do some statistical research work beginning with the new fiscal year July 1, 1944.

Nicholas F. Colovos, Research Assistant in Animal Husbandry, was granted military leave April 1, 1944. He is first lieutenant in the Sanitary Corps of the U. S. Army, doing specialized work for which his past training and experience have qualified him for an important contribution. He cannot be replaced here and our work is considerably handicapped as a result.

Technical assistants in Bacteriology have been very difficult to maintain. Miss Dorothy Tuttle resigned December 24, 1943. On February 1, 1944, we were able to obtain the services of Mrs. Harriet L. Mackel who had previously worked for us in Poultry. She also resigned April 30 and has since been replaced by Lawrence Morse, but not until June.

Joseph W. Enke whose contract as Research Assistant in Entomology terminated June 30, 1943, was replaced for this year by Wallace J. Morse.

Lewis C. Swain, Assistant Forester, has been taken over almost entirely in Extension work. However, he still maintains his interest in Sta-

tion affairs and because of University financing, has been able to function co-operatively in helping on occasion with Station projects. He will doubtless continue with advice and direction even though no Station funds are allocated for his salary next year.

William W. Smith returned from the Armed Forces in June, 1944. He has been re-assigned as Research Assistant in Horticulture. Russell Eggert, formerly part-time Assistant in Horticulture, was assigned for full time to the department for the year.

Poultry laboratory service work has been somewhat discouraging and difficult to administer, due to necessary changes among laboratory technicians and assistants. Miss Harriet L. Goodwin and Miss Madeline Papachristos both resigned. We were able to get the services of Donald A. Cross as an assistant technician in the laboratory before Mr. Cross had had experience. Miss Arline A. Nichols and Miss Ruth Rinta are also new people in the work. Henry E. Parker resigned as R. O. P. Supervisor, February 29, 1944, and his place has not been filled except as other members of the department have assumed some minimum part of the duties to keep this service alive.

Miss Elizabeth E. Mehaffey resigned as Mailing Clerk on February 29, 1944. This position was assigned to Miss Theresa R. Batchelder on June 12, 1944. No fewer than seven stenographers have been replaced during the year, and some of them more than once. Many good reasons for resigning, such as enlisting in the women's auxiliary services, marriage, war industries, etc., have sadly depleted our University clerical staff, and replacements of equal calibre and experience are most difficult to find.

PUBLICATIONS

Bulletins

348 Inspection of Commercial Feeding Stuffs for 1943
349 Result of Seed Tests for 1943
350 Inspection of Commercial Fertilizers for 1943
351 Agricultural Research in New Hampshire

Circulars

67 Small Grains and Corn Variety Tests

Technical Bulletins

80 Physiological Requirements and Utilization of Protein and Energy by Growing Dairy Cattle
81 The Composition of Timothy
Part I Young Grass and Hay
Part II Storage Organs

Scientific Contributions

90 The Characteristics of Crosses Between Botanical Varieties of Cabbage, Brassica Oleraceae; Am. Soc. for Hort. Sci., Vol. 43, 1943
91 How Much Borax Can an Apple Tree Tolerate?; Am. Soc. for Hort. Sci., Vol. 43, 1943
92 A Colorimetric Determination of Nicotinic Acid; Journal of Biol. Chem., Vol. 153 #1, April, 1944
93 Xylem Formation from Ring Grafts; Am. Soc. for Hort. Sci., Vol. 44, 1944

M. Gale Eastman
Director

AGRICULTURAL ECONOMICS

Operation of the Agricultural Conservation Program

The work this year has been directed toward postwar conservation programs, with particular emphasis on improvements necessary for the development of resources on commercial dairy farms such as preparing fields for efficient tractor operation, and rearranging, remodeling, or building new structures to insure effective use of labor in the handling of the dairy herd.

As a case study, a farm which is typical of a group of farms was replanned on the basis of anticipated postwar conditions. The changes required to raise the farm from 18 to 30 cow-capacity were studied. Previously, plans had been made for this farm on the basis of 20 cows; but the operator now believes that with the more general use of tractor power and better chore practices, he should eventually have a 30-cow farm. To develop field and pasture capacity for 30 cows, to prepare the fields for efficient tractor power, and to make efficient utilization of labor in chores, the following program would be required:

(1) Continuation and intensification of crop improvement practices on both crop and pasture land in order to raise the per acre yields and carrying capacity
(2) Conversion of 18 acres of present improved pasture land to crop land, requiring removal of some large rocks on land that was formerly tilled
(3) Clearing and improvement of 28 acres of present brush, timber, and permanent pasture land, and conversion to improved pasture
(4) Removal of 104 rods of stone fence
(5) Construction of 64 rods of diversion ditches
(6) Rearrangement and remodeling of barn, and building a new stable for 30 cows
(7) The construction of additional silo capacity

It is not anticipated that this operator can quickly carry out all of these improvements, but their attainment would result in an efficient 30-cow farm.

The list does not indicate that there are postwar improvements required on dairy farms in building agricultural resources and placing individual farmers in a position to produce efficiently.

H. C. Woodworth

The Supply and Distribution of New Hampshire Milk

The survey of milk transportation was completed during the year. The data are registered on a series of 20 maps and on a series of reference cards. Both maps and cards are on file in the Department of Agricultural Economics. Duplicate copies of the maps have been made available to the ODT and dairy transportation committees.

The maps show the location of each producer selling wholesale milk, the truck route hauling each producer's milk, and the market destination. The cards, one for each route, indicate detailed data concerning the travel and volume of milk hauled.

These data have been used by dairy transportation committees in Colebrook, Lancaster, and Grafton county (Middle-Connecticut Valley milk shed) in formulating reorganization plans for transportation of milk. The reorganization in these three milk sheds eliminates approximately 1000 miles of truck travel daily. (This includes some mileage saved on the Vermont side of the Connecticut River.)

The total mileage in New Hampshire for transportation of wholesale milk from 2691 farms to receiving stations was 12,606 miles daily. An average of 544,666 pounds of milk were transported daily. It is estimated that 680,000 pounds were hauled each day during the period of peak production.

Due to the scattered location of producers, but more especially to the duplication of routes and cross hauling, the mileage per farm was 4.68 miles. Only 43 pounds of milk were collected per mile of travel.

The dairy industry committee in Grafton County formulated a plan which indicates a saving of approximately 200 miles of travel daily. This committee was instructed by ODT not to disturb producer-processor relationship, and so cross hauling could not be eliminated. An analysis was made of the possible savings in transportation if areas were zoned for each plant and cross hauling largely eliminated. It was found that 700 additional miles could be saved daily.

The data indicate that the present pattern of milk transportation in central and southern New Hampshire is very complicated, and that reorganization of routes to obtain highest efficiency would require zoning of producer areas and shifting of present producer-distributor relationships.

The Colebrook Plan of Reorganization has been administered for over a year, and observations have been made from time to time as to the results. Under the plan at Colebrook, the area was zoned for trucking purposes. It has been observed that under this system, which gives a temporary monopoly to a trucker to transport the milk from a definite area, the relationships between producers and truckers have been under a strain in a few instances.

Under the old competitive system, truckers often rendered extra services to individual farmers. There has been a tendency for some of the truckers under the new plan to cut services to a minimum. There have been a few problem cases of inadequate services and failure to maintain goodwill. Because of aging equipment and shortage of labor, the truckers have had occasional difficulties in meeting their schedules.

The transportation of milk under the new plan was faced with a 25 per cent increase over previous years in milk produced in the flush pasture season, and the capacities of both processing and trucking facilities were taxed to the limit. There was often some delay in picking up loads due to labor shortage on farms, and there was difficulty in unolading at the processing plant. As a result, many of the truckers could not unload by 10 o'clock in compliance with the rules of the Boston Board of Health. This has always been a problem in the Colebrook area. The greater-than-usual difficulty this year was due mostly to the large increase in supply of milk during the flush pasture season.

H. C. Woodworth, J. C. Holmes

Feed and Egg Transportation

Possibilities of savings exist through co-ordinating transportation of hatching and market eggs. At the present time, the bulk of each type of eggs is handled by a separate carrier. Yet, farms carrying hatching eggs usually sell some market eggs; and, at times, may have to throw large quantities on the market. Early in 1944, huge quantities of hatching eggs were dumped on the market, and the facilities of our egg marketing organizations were taxed to the limit.

In July and August, 1943, 20 Strafford County poultrymen reported that 51 per cent of their eggs were going for hatching purposes and 49 per cent for market. Transportation in terms of volume was as follows:

37 per cent by producer's own truck or car
14 per cent by railroad express
49 per cent by trucks other than the producer's

Much duplication still exists on feed routes. Most concerns are now routing their customers' purchases and make few special trips except on full loads, but many different feed trucks travel the same roads. In the town of Barrington, 75 farmers reported purchasing nine brands of feed from 13 concerns located in five towns, and 16 per cent were buying from two or more concerns.

L. A. Dougherty

Purchasing Fertilizers

Early orders and acceptance of delivery for fertilizers are especially important in wartime in order to permit manufacturers to utilize labor and facilities to advantage and to insure a supply on farms at the time needed. Unsuitable storage or lack of space, fear of hardening, and inability to see any financial advantage are all factors which discourage delivery on fertilizer at an early date. Late ordering seems to be a habit that is hard to break.

In one instance a farm supply company gave a discount of $1.60 a ton for orders received before February 27, 1944. The tonnage sold before that date increased 75 times over the previous year. Another company inceased from almost no purchases before March 1 in the pre-war period to about 12 per cent in 1944.

At least one company makes gross savings of as much as $2 per ton available to producers for ordering in advance and taking delivery at car door instead of from warehouse floor. Furthermore, purchases for cash are making savings of from 1 to 10 per cent possible.

Discounts of $1 per ton are often available for purchases in ton lots. Further savings of 50 cents to $1 per ton are sometimes realized where purchasers are made in lots of 10 tons or more. In some cases, the larger lots are delivered from the factory to the farm at no extra charge, which is the equivalent of a discount. The location of the farmers is also a factor here.

Although many cases are found where a number of companies quote exactly the same price for fertilizer of a given analysis, considerable variation occurred in a few instances in 1944. A maximum difference of over $9 a ton was noted on 5-10-10 fertilizer in quotations of different compa-

nies and when the minimum of services were taken in connection with the lower price.

Larger amounts of the higher analyses fertilizers are being used with a savings to purchasers but too little progress has been made in this direction. Demands for certain chemicals for war purposes temporarily affected th availability of certain chemicals for high analyses fertilizers, but it is believed they will be used in increasingly large quantities after the war.

L. A. Dougherty

Recent Supply-Price Relationships for Potatoes

It is a well known fact that the per unit price of potatoes is relatively low in years when commercial producers have a large crop to sell, and that the price is relatively high in years when there is a small crop to sell. The deviation of potato prices from normal, however, is greater for small crops than for large crops; consequently, producers realize a greater gross income in years of short crops. The relation is not constant over a long period of years, thus corresponding price relatives vary according to current demand, which, for potatoes, is characterized as "inelastic," a purely relative term.

An investigation of the supply-price relationships for potatoes during the period 1900 through 1941 reveals facts which should be considered in planning for the postwar period.

The long-time trend in the per capita production of potatoes (representing per capita consumption) is downward. During this 42-year period, there have been no relatively large crops of potatoes since 1928. The year-to-year deviation from average was much less during 1929 to 1941 than during any previous period since 1900. Potato prices (U. S. farm) during these crop years of relatively light production (1929-1941), however, were relatively lower in purchasing power than for crops of similar size duing earlier years, but the price was more sensitive to changes in supply, particularly from 1930 to 1941. This new supply-price relationship is evidenced by a segregation of these 12 years (1930 to 1941) when each year of the entire period 1900 to 1941 is arranged on a dot chart showing the relation between per capita production and the December U. S. farm price corrected for price level. Thus, the period 1930 to 1941 has established a new demand curve to represent the supply-price relationships for potatoes. During this period production per capita varied between the relatively narrow limits of 10.5 per cent below average and 11.0 per cent above average, whereas a free-hand curve indicates that corresponding price changes ranged between 65 per cent above average and 27 per cent below average.

In the absence of ceiling and support prices during the postwar period, it may be assumed that the supply-price relationships for potatoes will return to the 12-year prewar period and not to a relationship representing an earlier or longer period, unless, of course, the demand curve shifts again as a result of changes in habits of consumption, or of some other unforeseen cause.

H. C. Grinnell

The Plan of a Small New England Town in the War and Postwar Economy

Northwood, an inland New Hampshire town, is contributing a large part of its labor force to war work and other activities outside its borders. Farming has continued to decline, and very little local industry remains. Even the overnight cabins and other recreational activities are closed.

While the people of Northwood may be more dependent upon employment in near-by cities than before, it is suggested that local resources and local opportunities be surveyed and studied by local people.

Can the dairy farms be combined or reorganized to afford real opportunities for a limited number of aggressive young men? Can some of the small industries be revised or new ones created to use local forest products and give employment to a few local people? Can the summer and recreational activities be expanded and developed?

The answers to these questions depend, in large measure, on the interest and adoption of local people; and it is suggested that all the possibilities be discussed so that individuals can more easily fit into the available opportunities and so that some definite community objectives that will support these activities can be developed.

D. Hosken

AGRICULTURAL ENGINEERING

Potato Storage Construction

An attempt was made to hold potatoes dormant until late January by the use of ice as a cooling medium. The storage bin was not insulated but was enclosed tightly and fitted with an ice compartment constructed to permit free circulation of air within the bin. The capacity of the bin was 150 bushels of potatoes and the ice compartment held about 400 pounds of ice. Technically, ice has proved to be a possible medium, but from a practical viewpoint the cost prohibits its use.

Detailed plans of construction are now available for a commercial storage having a capacity of 14,000 bushels and for a farm storage having a capacity of 1000 bushels. These plans are in accordance with past investigations at this Station and meet New Hampshire conditions.

P. T. Blood

Construction and Use of the Buck-Rake

During the summer of 1943 and June 1944, trials with the buck-rake proved that the rake would pick up 400 pounds of hay from the windrow or swath and that by "double-bucking" (placing one rake load upon another) at least 700 pounds could be gathered. A round trip from field to barn, including gathering, could be made every 10 minutes so that transporting two tons of hay from field to barn per hour was accomplished; after skill was acquired, as many as three tons per hour could be hauled.

A different hoist, using power from the engine, was installed during the winter of 1943-1944. This hoist enables the operator to raise and lower the rake, and to hold it in position, by using only one lever, and to do this whether the machine was moving forward or backward, or was motionless.

Further time trials are to be run and will include the use of an all-wood rake built during the winter of 1943-1944.

E. W. Foss

DAIRYING

Analysis of D. H. I. A. Records

A total of 4030 lactation records of cows in New Hampshire Dairy Herd Improvement Associations was used as a basis for the analyses. In many of the comparisons the data were analyzed separately for each breed to determine breed differences. Some of the more noteworthy results follow:

I. Month of freshening: (1) Summer months are more associated with lower lactation yield than are fall and winter months. Jerseys showed no significant relation. (2) Month of freshening had no significant effect on length of lactation. (3) Cows freshening in mid summer and late summer return less milk per unit of grain fed during lactation than at other times of year.

II. Age: (1) Maximum production was obtained from cows at five to six years of age in most instances. (2) Lactations made prior to three years of age were definitely longer than those made after that age. (3) Without exception, each breed showed a wider milk-grain ratio when three- to four-year-old group was compared with two- to three-year-olds. There were no consistent changes between remaining age groups.

III. Dry period: (1) Subsequent lactation yields were highest for a dry period approximately 65 days, with very little variation between 45 and 85 days. There was an abrupt increase in yield as the dry period increased up to 40 days. (2) There was no consistent practice regarding amount of grain fed during dry period. Jerseys were fed much less grain than other breeds.

IV. Length of lactation: (1) Lactations of approximately 12 months appear most desirable to secure maximum 305-day milk production.

V. Milk yield and grain feeding: (1) The data indicate the principle of diminishing returns in that for all breeds additional increases in grain feeding created progressively smaller responses in milk yields. (2) The correlation between increased milk yield and milk-grain ratio was positive.

This study indicates the influence of certain herd management practices on milk production. Attention on the part of dairymen to the application of these relationships would directly affect the amount of milk produced on New Hampshire farms.

K. S. Morrow, H. A. Keener

Management Practices in University Herd

This project, designed to supplement the findings of the previous project, involves detailed analyses of certain management practices covering the past 25 years in the dairy herd at the University of New Hampshire.

Work on the project to date has consisted entirely of preparing production data for tabulation. All records of milk and butterfat are being

converted to a common 4 per cent fat-corrected-milk basis so as to make breed comparisons possible. Also mature equivalent yields are being figured for each lactation reported.

The data will be tabulated for statistical interpretation.

K. S. Morrow, H. A. Keener

Chore Efficiency

The study of chore efficiency this year has been confined mostly to milking procedure. On account of the farm labor shortage, greater immediate assistance could be given dairymen by concentrating on this chore practice which tends to limit production on individual farms.

Three dairy herds were shifted over to the fast-milking procedure on a trial basis during August (1943). This is a method of stimulating the let-down of milk as developed by W. E. Petersen of Minnesota. On one farm, a record taken on August 28, before conversion, shows an over-all time of 87.6 minutes for milking 34 cows. The machines were left on the cows an average of 6.6 minutes. They were on 12 cows for a period of 7 minutes or more, and on one cow for over 12 minutes.

The shift to rapid milking was made on August 28, and a record was taken on August 31. At this time, the same two men with the same equipment milked 33 cows in 59.4 minutes. The average time the machines were on the cows was reduced to 4.2 minutes, and the longest period the machines were on any one cow was 5.3 minutes. Only six cows were milked longer than 4.5 minutes. There was a slight reduction of milk the second day under the new procedure; but on the third day, production was back to normal. The amount of stripping was about the same as before conversion.

Records were taken on 20 farms in the spring of 1944. In each case, the operators had shifted over to the fast-milking procedure. The lowest average time that the milking machines were used on cows was slightly less than 3 minutes. In this case, the over-all machine time was 3.65 minutes per cow. The operator and his 15-year-old son milked 40 cows with two single units in 73.5 minutes. This over-all time can be reduced later when the operator makes changes in his procedure in handling the milk. The use of a third unit could reduce the total milking time but would involve an additional investment.

The first emphasis in this study was directed toward the possibility of reducing the time the milkers were used on the cows. In the last half of the year, the study has given attention to the combination of machines and men and procedures that would give best results.

This analysis is not complete, but a few points are mentioned here. Certain operators lost time because of failure to group the cows to be milked by the machines. Cows milked by hand are often scattered through the herd, and stalls between milkers are not in use. In the process of milking, stripping, and handling the milk, an operator travels back of the cows from seven to twelve or more times depending on the procedure followed. Assuming an average travel of 10 trips back of the cows, each stall represents a daily travel of about 70 feet. In one herd of 50 cows, about 800 feet of extra travel was involved daily, largely because the cows milked

by hand were scattered throughout the herd. In another herd of 30 cows, the failure to group cows resulted in about 600 feet of extra travel.

On most farms, additional milker unit pails are required to take full advantage of the fast-milking procedure. Certain operators have learned to shift the milker head from a full to an empty pail very quickly and the machine is in operation on another cow within a short period. With extra pails at hand, the milking machine unit is in operation while one of the men carries the full pails to the milk house.

The best combination of men and machines varies from farm to farm, due to differences in size of herds and variations in personnel. On a few farms, the labor of older men or young boys required adjustments in the usual pattern of the milking practice. The data indicate that the combination of two single units and two men does not make the most effective use of man labor. Three single units and two men make a good combination.

One operator did very well with two single units, and another man handled one double unit to advantage. Two young men, using two double units, milked 30 cows in 37½ minutes (a very good record). In one large dairy, four single units were too much for two men when using the rapid-milking procedure; but the operator had so skillfully combined the labor of three men in the combined tasks of milking, preparing cows, stripping, carrying, and cooling milk, that the system was very efficient.

H. C. Woodworth, K. S. Morrow, M. E. Tarbell

Dry Rations for Raising Dairy Calves and Heifers

Twenty calves were used in a study of dry rations which contained no animal protein, and in which pulverized limestone and salt were added as mineral supplements. Two of these animals were used in conducting four nitrogen and energy balance experiments in which the vegetable-protein ration was compared with a ration containing 20 per cent skim milk powder. Eight of these animals, paired as to breed, age, and sex, are being used to further compare the vegetable protein ration to the ration containing an animal protein of 20 per cent skim milk powder. Results have been determined by means of growth and general appearance and by relative blood content of carotene, Vitamin A, nicotinic acid, ascorbic acid, cholesterol, non-protein nitrogen, glucose, calcium and phosphorus.

The all-vegetable protein dry calf ration has produced at least normal growth with Holstein and Guernsey calves. Results with Jerseys were not as satisfactory, but were as good as results previously obtained on dry calf rations containing 25 per cent skim milk. There was no significant difference in digestibility of the protein or energy between the two rations, but in both cases there was a slightly greater positive nitrogen balance on the vegetable protein ration. Levels of the various blood constituents for which analyses were carried out were not significantly different from those obtained on calves fed the usual animal proteins or the normal values reported in the literature.

Results so far indicate that dry calf rations which contain soybean oil meal as a major source of protein, and dried distillers' solubles as a source of nicotinic acid and the other members of the Vitamin B complex will give as good results as the older-type ration which contains cottonseed meal, linseed meal, and dried skim milk. When ingredients which contained

fairly good amounts of phosphorus were included, normal calcium and phosphorus levels were maintained in the blood with only pulverized limestone and salt as mineral supplements.

The nitrogen and energy balances were carried out in co-operation with the Animal Husbandry Nutrition Laboratory.

K. S. Morrow, H. A. Keener, S. R. Shimer, N. F. Colovos, A. E. Terri

Improving the Solids-Not-Fat Content of Milk by Selective Breeding

Sixteen sires have now been proven, including nine Holsteins, three Ayrshires, three Jerseys, and one Guernsey. Ten of the 13 sires on last year's annual report were re-proven by adding new lactation records.

Ten sires increased and six sires lowered milk production; 11 increased and five lowered fat percentage; 11 increased and five lowered the percentage solids-not-fat. Eight sires increased both the fat and the solids-not-fat percentage; two lowered both the fat and the solids-not-fat percentage; three increased the fat percentage and lowered the percentage solids-not-fat; and three decreased the fat percentage and increased the solids-not-fat percentage.

Placing the sires in groups where fluctuations were similar with reference to milk production, percentage butterfat, and percentage solids-not-fat (Ex. +milk, —per cent fat, +solids-not-fat; +milk, —per cent fat, —per cent solids-not-fat, etc.) and averaging the figures, the following table results:

No. of Sires	Milk lbs.	Fat per cent	S. N. F. per cent	*Variation from expected normal S. N. F.
5	—1,157	+0.35	+0.174	0.034
3	+ 826	+0.09	—0.11	0.146
3	+ 516	+0.20	+0.20	0.120
2	+1,698	—0.04	+0.08	0.096
2	+1,181	—0.13	—0.08	0.028
1	— 19	—0.17	+0.19	0.258

**These figures are calculated on the basis that an increase in the 1 per cent fat is accompanied by an increase of about 0.4 per cent solids-not-fat.*

The influence of inheritance in affecting the solids-not-fat in milk is illustrated in the study of a single cow family. Cow No. 102 with a record of 9390 pounds milk, 3.61 per cent fat, and 8.27 per cent solids-not-fat, was the great granddam of two full sisters, No. 240 and No. 271, with records of 10672 pounds milk, 3.81 per cent fat, and 8.82 per cent solids-not-fat; and 10663 pounds milk, 3.63 per cent fat, and 8.40 per cent solids-not-fat, respectively. The high solids-not-fat test (8.82 per cent) of cow 240 was very likely due to the effect of sires B and L that both raised the solids-not-fat content, whereas the low solids-not-fat test (8.40 per cent) of cow 271 reverts to the test of the great granddam (8.27 per cent) and the granddam (8.40 per cent). The dam of 240 and 271 had a record of 8.75 per cent solids-not-fat.

The results with the sires and the cow family indicate that the three factors, milk production, percentage butterfat, and percentage of solids-not-

fat, may be inherited separately, and that it is impossible to predict the solids-not-fat change from a change in fat per cent.

H. C. Moore, H. A. Keener

Studies on Bovine Mastitis

Studies were continued on the control of mastitis by segregation and by treatment of cows infected with streptococcic mastitis. Forty-one cows were treated with sulphanilamide in oil during lactation; 29 (70.6 per cent) of the cows and 61 (74.4 per cent) of the quarters were cured. Four (80 per cent) of the five cows and eight (88.8 per cent) of the quarters treated with sulphanilamide during the dry period were cured. Seven cows were treated with novoxil during the dry period; seven (57.1 per cent) of the cows and nine (64.2 per cent) of the quarters were cured. In the group of five cows treated with tyrothricin during lactation, four cows (80 per cent) and 11 quarters (84.6 per cent) were cured.

The following results were obtained on cows treated for staphylococcal mastitis; (a) None of the five cows and only four out of the 15 quarters treated with sulphanilamide in oil were cured. (b) One cow out of seven and only three out of 16 quarters were cured when treated with tyrothricin. Twelve cows were injected with an autogenous herd staphylococcus vaccine but no improvement in the mastitis condition could be detected.

It should be noted that the above results are based on treatment of cows infected with either a mild or with a more acute or chronic type of mastitis infection. As previously reported, it has been found that cows with acute infection, or with long-standing chronic infections, may not respond to treatment. When sulphanilamide in oil was used for treatment of lactating cows, the best results were obtained when two injections of from 50 to 100 *ml.* were given per quarter at 24-hour intervals. The drug was allowed to remain in the udder for a 24-hour period before milking out the quarter.

Studies were also continued on the staphylococci from udders of cows. A paper is being prepared on the characteristics of these organisms and their toxins.

L. W. Slanetz, F. E. Allen, T. Sicilian

FIELD CROPS

Rotation, Fertility, and Cultural Experiments With Potatoes in Northern New Hampshire

Much of the previous experimental work located at the Coffin farm near Colebrook was continued during 1943 and is being repeated during the current 1944 season. Calcium sulphate was applied to potato plots in varying quantities as a supplement to normal fertilization. There has been no attempt to obtain fertilizers without calcium and sulphur. Gypsum was broadcast in varying amounts and was harrowed in before planting. The resulting average yields for a two-year period were as follows:

Amount of gypsum	Yield per acre	Increase in yield over no gypsum
None	246.6 bu.	-0-
500 lbs.	272.7 bu.	16.1 bu.
1000 lbs.	304.0 bu.	57.4 bu.
2000 lbs.	305.8 bu.	59.2 bu.

Supplementing normal fertilization with gypsum, not in excess of 1000 pounds, would appear to be a profitable practice in the Colebrook area.

The fertilizer-placement experiment involves a comparison of broadcasting with banding. The results follow:

Method of application	Yield per acre	Reduction in yield below banding
N, P and K banded	276 bu.	-0-
N and K broadcast, P banded	230 bu.	46 bu.
N broadcast, P and K banded	234 bu.	42 bu.
N, P and K broadcast	244 bu.	32 bu.

These results are not identical with those of previous years, but there is evidence that over a period of years greater yields may be obtained by banding all ingredients than by any other method of applying fertilizer. The method of banding complete fertilizers by machinery has the added advantage of economy of application.

Another fertilizer experiment on potatoes consists of comparing various ratios of ingredients, while the amount of nitrogen was kept at a constant level of 80 pounds per acre.

Fertilizer application

Analysis	Ratio of ingredients	Pounds per acre	Yield per acre	Increase in yield above the 1-2-2 ratio
5-10-10	1-2-2	1600	306 bu.	-0-
4-12-12	1-3-3	2000	320 bu.	14 bu.
4-8-16	1-2-4	2000	317 bu.	11 bu.
4-16-8	1-4-2	2000	316 bu.	10 bu.
4-16-16	1-4-4	2000	334 bu.	28 bu.

The resulting variations in yield were narrow; consequently no definite conclusios can be drawn as to the relative profitableness of the various applications.

In addition, the above three lines of work upon which yield records are obtained annually, three rotations are in progress in which potatoes are grown (1) in continuous culture, (2) in a two-year rotation with cover crops in the alternate year, and (3) in a four-year rotation in which oats and two years of hay are utilized. Studies of organic matter and soil structure are to be made of samples collected at the beginning and at the end of a five-year period.

So far, the two-year rotation has been the most assuring. Crimson clover, rye grass, and oats have been used as cover crops. Crimson clover does well in the area, and good crops have been plowed under. The land which grew crimson clover in 1942 produced the largest yields of potatoes in 1943. However, it was found, upon examination of the tubers, that the potatoes from this area were seriously affected with net necrosis and stem-end browning, while very little of these troubles appeared on any other treatments. The cause of this difference is not certain; and, unfortunately, as such a difference was not anticipated, only one small bag of tubers was saved from the area. Work is currently under way to determine the causes.

P. T. Blood, F. S. Prince, L. T. Kardos

A Dairy Farm Rotation Experiment in Southern New Hampshire with Sweet Corn as a Cash Crop

In 1943, sweet corn was again grown with varying amounts of fertilizer. New strains of timothy which have been developed in the plant-breeding program were seeded on the plots that had been in corn during 1942. Erban and Vanguard oats were used as nurse crops. These high-yielding Canadian varieties are difficult to obtain, and the seed produced is being distributed to farmers who will again multiply them. The timothies seeded in 1942 will be harvested for seed in 1943. This procedure is repeated for the 1944 seedings.

Treatment	Yield in tons of ears per acre	
	Not side dressed	Side dressed
4-12-4 (1000 lbs.)	6.8	6.17
3-12-6 (1000 lbs.)	5.99	6.79
4-9-7 (1000 lbs.)	5.72	6.01
4-10-10 (1000 lbs.)	5.73	6.28
Average	6.01	6.31

The data give the yields resulting from the use of four grades of fertilizer which farmers used in 1943 under limitations due to war conditions. There were no significant differences. An increase in yield of approximately 0.3 tons of ears per acre was effected by the application of 200 pounds of Chilean nitrate of potash at the last cultivation. The amount of this increase depends on the previous fertilizer treatment and on subsequent weather. Whether or not the application is economical depends upon the cost of the fertilizer and the farm price of the corn.

F. S. Prince, P. T. Blood

Producing the Full Roughage Requirements on New Hampshire Dairy Farms with Special Reference to Pastures

This project was started in 1942 and involved, among other things, the reseeding of old pastures and seeding field land with the intention of utilizing it as pasture. Some areas were plowed, some were fitted with a bush-and-bog harrow, and others were plowed and harrowed. A seed bed can be prepared with a bush-and-bog harrow in about 60 per cent of the time required for plowing. The bush-and-bog harrow has a further ad-

vantage of wider adaptation to land too stony or stumpy for plowing, and, also, it leaves more of the organic layer on the surface which may be of some significance in water absorption . There has been little or no difference in the appearance or yield of the stand between the two methods of seed bed preparation.

The seedings included one or more of the following grasses with Ladino clover: orchard grass, smooth brome grass, reed canary grass, tall meadow fescue, perennial rye grass, and two strains of timothy, namely, Milton and Cornell 1777. The areas so seeded were managed as pasture during a part or all of the 1943 season, and all of those areas caged and harvested were pastured all of the season. Since all areas had been adequately fertilized and limed in 1942, no lime, superphosphate, or potash were applied in 1943. Several of the pastures were divided crosswise of the plots, however, and nitrate of soda was applied at three levels (leaving untreated check strips) to note the influence of nitrogen or yields and its effect on the persistence of the Ladino clover. Two of the pastures on which nitrogen was applied at different levels were harvested and the respective yields noted. The results follow:

Nitrogen level	Response from nitrogen on seeded pastures, Oven dry weight, pounds per acre	
	Angell pasture	Peters pasture
100 lbs.	6648	5576
200 lbs.	6168	5795
300 lbs.	6929	----
No treatment	5604	5753

In the Angell pasture, the soil is a loam and subject to drought, whereas the Peters pasture is a very heavy soil and perhaps somewhat less affected by drought. These facts may explain why greater response was secured in the Angell pasture. Ladino clover growth was vigorous on all plots and undoubtedly had considerable effect on the yields of other grasses. The variations in yield per acre among these grasses is not great. It is conceivable that as the Ladino clover disappears greater differences may occur.

A rate-of-seeding experiment was conducted in one pasture for orchard grass. One plot each was seeded at the rate of nine, six, and three pounds, and the resulting yields were 6210 pounds, 5548 pounds, and 4908 pounds, respectively. Ladino clover was included in all plots at the rate of two pounds per acre.

The Department of Agricultural and Biological Chemistry, cooperating, has made supplementary observations on these pasture experiments.

The light soil pasture was sampled by levels and there was a steady decline in available nitrates as the season progressed. The plots receiving higher applications of N had the highest level at the start of the season.

The pasture on the heavier soil had a very good stand of Ladino clover with some red clover. Three levels of nitrogen were applied and half the plots were cross treated with three levels of phosphorus and potash. There was a significant increase in yield in pounds of protein per acre whenever the half of the plot receiving complete fertilizer was compared with the

half receiving nitrogen alone. The amount of total nitrates in parts per million stayed fairly low throughout the season. The amount of available potassium was higher on fertilized plots and the available phosphorus was fairly uniform throughout. Due to the severe winter considerable winter killing occurred in this pasture; however, the completely fertilized plots wintered the best, due to location. They were again fertilized this spring with varying amounts of complete fertilizer. Samples of pure stand of Ladino and red clover were taken in order to ascertain whether or not increasing amounts of potash applied as a fertilizer decrease the calcium content of clover significantly. These samples will be analyzed during the coming year.

F. S. Prince, P. T. Blood, G. P. Percival

The Relation of Potash Levels to the Persistence of Clover in Hay Stands

This project is located on a terrace of the Connecticut River.

Plots 1 to 46 inclusive were reseeded in 1942 and harvested twice in 1943 after having been top-dressed with potash variables supplementing the application of uniform nitrogen and phosphoric acid early in May. The resulting yields were evidence of the efficiency of manure and potash in the production of hay.

Treatment per acre	Yield in pounds per acre	
	Total	Increase due to treatment
1. Check plot - no treatment	5140	----
2. 10 tons manure at seeding	6136	996
3. 20 tons manure at seeding	6446	1306
4. 100 pounds muriate annually	5880	740
5. 200 pounds muriate annually	6179	1039
6. 300 pounds muriate annually	6280	1140
7. 20 pounds borax and 8-16-16	6151	1011

It is too early in the test to draw conclusions concerning the persistence of clover.

On the unplowed portion of the field, plots 47 to 80 inclusive, the grass was harvested only once in 1943. Clover still persisted in the plots which had been treated with potash consistently.

Annual treatment per acre	Yield in pounds of cured hay per acre	
	Total	Increase due to treatment
1. Check plot - no treatment	1909	----
2. 125 pounds KCl (since 1942)	2306	397
3. 500 pounds 8-16-16	3890	1981
4. 125 lbs. KCl, 500 lbs. 8-16-16	4814	2905
5. 125 lbs. KCl (since 1937)	3092	1183
6. 400 lbs. 0-20-20	5228	3319
7. 500 lbs. 8-16-16	5601	3692

The above data are significant for maintaining hay yields at a high level and indicate the importance of top-dressing. Contrast, for example, the two treatments, 2 and 5. Series 5 was treated annually since the plots were seeded in 1937, whereas in series 2 treatment was applied only in 1942 and 1943 to plots which had received no potash during the preceding years in the life of the stand. The yields show that the plots which had been top-dressed each year yielded nearly 800 pounds more of hay than those in which the treatment was omitted during the early years. During these early years, many of the desirable hay plants like clover and timothy disappeared because of lack of plant food, and their places are filled by less responsive species which are not high yielding under any system of fertilization.

This point is further emphasized by comparing plot number 7 and 3 and 4 which have been treated in equal amounts since 1942, although prior to that and since 1937, plots 3 and 4 had not received a complete fertilizer. The difference in yield between the two series for 1943 is 1711 pounds of cured hay per acre, signifying that by the time heavy top-dressing began on plots treated with 8-16-16 there had been a considerable reduction in desirable species.

Some clover persisted in 1943 in the plots treated with potash, but yield differences are due mainly to maintaining timothy in the stand. Those that had been fertilized generously over the years have a fairly good percentage of this specie.

The Department of Agricultural and Biological Chemistry, co-operating, continued a greenhouse comparison of metapotassium phosphate with an equivalent amount of potassium chloride and superphosphate. The plots were divided into halves and one-half was treated with nitrate of soda at the rate of 40 pounds of nitrogen per acre. Cornell 29-3 Double Cross Corn was planted. The corn was harvested when tasselled and a comparison of the dry weights shows that there was no significant difference between treatments.

The comparison of equivalent amounts of potassium chloride, potassium sulphate and potassium metaphosphate on the near virgin soil taken from the farm on the Connecticut River terrace was continued without additional fertilizer applications. Again potassium sulphate and potassium metaphosphate gave significant increases in dry matter over the check. Another crop of corn is now growing in these same plots and all plants indicate a marked deficiency of potassium.

Some of the plots were sampled last fall by levels for available nutrients. The results show that there was more available potash present in the plots that still had a good growth of red clover than in the plots where it was absent.

F. S. Prince, P. T. Blood, G. P. Percival

Oat Variety Trials in Northern New Hampshire

This experiment is being conducted in the Colebrook area, and has been in progress three seasons.

Data secured from the trials were published in Experiment Station Circular 67, February, 1944. Yields of different varieties are tabulated on pages 8 and 9 of that publication. In general, the results indicate a differ-

ence of about 20 bushels per acre between the highest- and lowest-yielding varieties. Of those tested, Erban and Vanguard, two Canadian varieties, and Upright, a variety developed in the States, rank highest in yield for this experiment.

Some of the newer disease-resistant strains of oats have been introduced during 1944, along with the three high-yielding varieties mentioned.

P. T. Blood

Silage and Field Corn Trials

Corn variety tests have been carried on for about eight years on the Whenal Farm in Greenland. Each variety has been replicated three times and yields determined, based on the dry matter and moisture percentage obtained from randomized samples dried in the steam-heated drier.

1. Corn for Grain

Twenty-two varieties and dent hybrid strains of corn were planted on May 21, 1943. In each case, the three randomized plots were thinned so there were three plants in each hill. On October 7, the ears of each replication were picked and weighed. Samples in triplicate of 12 ears each, picked out at random, were dried to a uniform moisture percentage of about 8 per cent which were used for calculating the yields on an equal basis.

"New Hampshire 500" used as a check with the Minhybrids 700 and 800 series again gave good yields of mature grain corn. The results for 1943, as well as for 1942, are summarized in Station Circular 67, "Small Grain and Corn Variety Tests," February, 1944.

2. Silage Corn

In 1943, twenty-two silage corns, including several new hybrids, were planted on May 21. Perfect stands were obtained by heavy planting and then thinning to three plants per hill. Twelve hills of each replication were cut and weighed on September 13. One hill of each replication was bagged and dried to a uniform moisture percentage in order to obtain the per cent dry matter and yield per acre.

Of the new hybrids Ohio 66 again led in silage of dry matter per acre, but Ohio 66 has been discontinued due to cost of seed. This goes to show that new strains may yield well but they may not stay in production. In the Agronomy corn trials over a period of eight years Lancaster Sure Crop, Cornell 29-3, and West Branch Sweepstakes have been the most consistant producers of good yields of corn silage. In 1943, a season of low rainfall, all varieties produced over 9,000 pounds of dry matter and over 21 tons of green weight per acre.

L. J. Higgins

Advanced Alfalfa Nursery Trials

The advanced alfalfa nursery plots were seeded in 1941 on the Whenal Farm, Greenland, New Hampshire. Each of the six varieties was replicated five times. In 1943, three cuttings were made as in 1942 and the per cent dry matter was calculated from randomized samples dried in the steam-heated drier.

A-145 New Jersey, now named "Atlantic," came up from second place in 1942 to first place in 1943 with a yield of 2.98 tons per acre.

Grimm, a reliable variety for the Northeast, dropped from first place in 1942 to fourth position in 1943 with a yield of only 2.72 tons. The resulting yields in tons per acre follow in descending order:

1.	A-145 New Jersey	2.98
2.	Dakota Common	2.82
3.	A-69 Michigan	2.81
4.	Grimm	2.72
5.	A-67 New Jersey	2.67
6.	A-68 Michigan	2.62

In May, 1944, these plots were plowed up since very few plants survived the severe winterkilling. "Atlantic" showed a range of 5 to 30 per cent survival in the five replications while Grimm's survival range was from nearly zero in four plots to about 20 per cent in the fifth. The estimated percentage of surviving plants follows in descending order:

1.	A-145 New Jersey	12 per cent
2.	A-68 Michigan	9 per cent
3.	A-69 Michigan	7 per cent
4.	A-67 New Jersey	6 per cent
5.	Dakota Common	6 per cent
6.	Grimm	5 per cent

Since "Atlantic" shows some promise as an alfalfa variety it should be given further trials.

L. J. Higgins

Oat Variety Trials

Twenty-five varieties of oats were planted in the Agronomy Plots at Durham, New Hampshire, on May 13, 1943. These plantings were rod rows and were in three randomized replications. The seed was furnished by the United States Department of Agriculture and included several new disease-resistant varieties. Four standard varieties were used as checks.

Each row was harvested and weighed for forage yield after the bundles were field-dried. The heads were cut off, bagged, and then threshed by hand to determine given yield per acre. Varieties such as the Vicland, Vanguard, and Ajax, which show some resistance to the prevailing oat diseases in southeastern New Hampshire, gave excellent yields. Some of the old standard varieties did very poorly.

The summarized results of these oat trials appear in Station Circular No. 67, "Small Grain and Corn Variety Tests," published in February, 1944.

These trials are being continued in 1944 on a larger scale and with additional varieties.

L. J. Higgins

FORESTRY

Propagation of Sugar Maples

Several hundred cuttings of current season's growth were collected from trees known to possess a high sugar concentration. These were se-

lected from three different locations in the state. They were placed in shaded beds in the greenhouse and in shaded sash-covered beds outside. The amount of rooting was not as great as during the previous season. The highest per cent of rooting was with Hormodin, 33 per cent, but on a small number of cuttings. The average of all rooted lots was 9.6 per cent. No rooting occurred in the outdoor beds.

These cuttings were removed to the forest nursery in August. The leaves were shed promptly, but the condition of the cuttings could not be determined until spring, when it was evident that none of them had survived the winter. It seems clear that it is not a satisfactory procedure to move them until the following spring, without taking more than ordinary precautions. Several different methods of handling rooted cuttings will be tried during the coming year.

In the sap quality study a series of eight sugar maples were tested each day, and, on one occasion, every hour during the daily run. The quantity of sap produced was measured when weather conditions made it possible. The pH content was determined at frequent intervals for more than 200 samples by Dr. Joseph Seiberlich of the Engineering Experiment Station. The average of all tests showed a pH of 6.638, and the range was 6.03 to 7.23.

In general, it may be said that the sugar content of the sap was highest during the early part of the season, decreased gradually, but showed a tendency to increase toward the end of the season. All trees followed the same trend but on most days the relative sweetness of the sap remained about the same, *i. e.*, the sweetest trees at the start still yielded the sweetest sap at the end of the season. Similarly, hourly tests of the sap indicated that the highest sugar content is obtained during the first run in the morning, and the sweetness gradually declines during the day with a slight rise toward evening.

The sweetest trees produced the most sap. The sap from these trees seemed to be running faster than from the others, but there is also some evidence that these trees started running earlier in the morning than did the others, and ran until later in the afteroon.

The acidity of the sap varies somewhat from tree to tree and from day to day, but it was evident that all the trees showed the same trend, all being more acid on some days and less acid on others. Although the data are not conclusive because the sap tested was not always fresh, it appears that there is some correlation between the acidity and the sugar content; on days when the pH is low the per cent of sugar present is also low. Further investigation of this point is needed to determine the causes of variation in acidity.

In an attempt to correlate the weather conditions with the quantity and quality of sap, an instrument shelter was set up in a red maple stand, and three thermographs were installed to record the temperatures of the air, of the soil, and of the interior of a tree. The air temperature in the open was recorded by a thermograph housed in a second instrument shelter maintained by the Department of Horticulture. Data on barometric pressure and precipitation were obtained from the weather station operated by the Department of Geology. No correlation between the weather and quality of the sap is evident as yet and further investigation is needed on this phase of the problem.

There is some evidence that the quantity of sap is directly influenced by air temperature. To determine this relationship a series of thermocouples were installed at several places inside the bark of red maple trees. Red maples were used because there was not sufficient number of sugar maples of a satisfactory size growing close together. This part of the experiment led to some very interesting and important results which are being prepared for publication. Trees about 8 inches in diameter and 40 feet tall were severed from the stump and set upright in barrels of water. One was left with all branches intact, one was stripped of all branches, and one was stripped of all branches and placed in the barrel upside down. Each was tapped and a spout inserted. Sap of normal quality flowed from each tree on the same days and during the same hours that it flowed from control trees nearby. In the same way, sap flowed from each section of a tree cut into eight-foot logs and set into a barrel, whether upright or inverted. No sap flowed from spouts in two eight-foot sections of the same tree which were placed upright on a dry base. One section was placed horizontally and the butt end inserted in an old inner-tube filled with water. Sap flowed from each of three tap holes spaced at intervals of two feet. It was later cut into pieces two feet long and these were set into a bucket of water and tapped. A tiny quantity of sap was produced, but this was so late in the season that the experiment was not considered satisfactory. In each tree and in each section all cut surfaces not immersed in water were sealed with grafting wax to prevent undue drying out of the tissues.

The results of this experiment lead to the conclusions that root pressure, so-called, is not necessary for the flow of maple sap in early spring. Nor is there needed any lifting power which might be ascribed to transpiration in the buds, twigs, or branches. Observations of the internal temperatures of the tree and of the fluctuations of the water in the barrels around the base of the severed trees indicate that sap flow is influenced largely by the temperature of the air.

It has long been a maxim that maple sap flows best on a warm day following a freezing night. This was observed in all our experimental trees. The thermograph inside the tree indicated that it takes some time for external temperatures to penetrate to the heart of the tree, and that the wood at the center is still relatively warm after the temperature of the air has dropped several degrees below freezing. The thermocouples in the cambium region, however, showed that this area cools off rather rapidly, and the sap here freezes long before that deeper in the wood. This is especially noticeable in the upper parts of the tree. Ice crystals form in the tissues here, resulting in a more concentrated cell solution, due to the sugar present in the sap. This sets up a tension which draws the sap from the interior of the tree toward the exterior, where it freezes. As the temperature drops, this freezing penetrates toward the heart and down the trunk, and more and more moisture is drawn up from the roots and the lower part of the trunk. When the temperatures goes low enough the whole trunk is frozen and no more moisture is absorbed. On the following day, as the air warms, the ice melts and the sap flows out at any convenient opening.

As will readily be seen, the longer it takes for the interior of the tree to freeze the more sap will be drawn up into the tissues, until the saturation point is reached. If the temperature drops rapidly and goes quite low,

the inner wood freezes faster and less moisture is absorbed, and, consequently, less sap will be available the following day. This seems to be the chief relation between the weather and the quantity of sap. It should be emphasized that while this is apparently the case, we do not yet have enough evidence to consider it conclusive, and at least another season will be necessary to check the results. The apparatus used this year was not satisfactory because it failed to keep rain and snow from the buckets; wind bothered by blowing off covers and evaporating sap; and only four of the buckets were large enough to hold a day's run of more than 3,000 c.c. In 20 cases these small containers were running over when visited.

C. L. Stevens, S. Dunn, R. Eggert

Plantation Studies

Due to the labor shortage, only two small plantations were established during the spring of 1943. The nursery is well filled with trees that should be moved out and planted, and there are a number of seed beds in which the seedlings are ready for transplanting. The routine examination and measurement of plantations have been carried on as usual, and there is a decided increase in mortality in the hardwood areas, as predicted last year.

In the study of sprout reproduction the old stumps were measured last fall and 50 new ones have been added to the series during the spring of 1944. The seeds of 10 local species of trees were collected in the autumn and 10 more were purchased from a seed dealer. These were put through the usual tests and the surplus seeds have been sown in the nursery to provide material for future plantations.

In October, a number of white oaks were added to the experiment on transplanting freshly germinated hardwood seedlings. Results this spring have not been encouraging, due in part to the extremely cold weather last winter before snowfall, and in part to the drouth this spring. We now have four species in the test and more will be added next spring. (1945.)

C. L. Stevens

White Pine Stands

In the seed-production study the cones were at the end of their first year of development last autumn. They will be ripe this coming fall, when it is planned to get a somewhat better collection than was possible during the last seed year. Next spring a second series will be added. The data are still too few to support any valid conclusions.

C. L. Stevens

Determination of the Supply of Low-Grade Wood Available for Manufacturing into Plastics

Close co-operation with the Engineering Experiment Station has been maintained in providing wood samples from various tree species for experimental use in the development of plastics manufacture. The preparation of samples involves cutting uniform bolts of white pine, red maple, elm, and gray birch, and reducing them to chips or shavings which can be processed easily.

Separate samples containing sapwood alone, heartwood alone, and mixtures of both heartwood and sapwood were prepared.

Twenty-pound samples of red maple were made, both from freshly cut and partially seasoned bolts. The method of reducing bolts to shavings or chips is to peel all bark and plane the peeled bolt on a 6-inch power jointer. The size of chips may be varied by lowering or elevating the rear table of the jointer.

Sapwood chips are secured by planing surfaces around the bolts until the heartwood is reached. The center portion is then chipped for heartwood samples. By planing without turning the bolts, a mixture of heart and sapwood is produced.

L. C. Swain

FRUIT PRODUCTION

The Effect of Fertilizer Elements on Apples and Leaf Scorch in Deciduous Fruit Plantings:

Leaf scorch of McIntosh has not yet been reduced by mulching with hay. Sawdust-mulched trees from the paler color of their leaves, show a state of nitrogen deficiency. Trees mulched with hay are making the best growth. Treating the soil with magnesium sulphate has not been effective in controlling leaf scorch in the experimental orchard plots.

Soil samples from under two trees affected with arrowhead leaf scorch were taken into the greenhouse and placed in a bench divided into plots. All plots were fertilized with nitrogen then differentially treated with calcium lime, magnesium sulphate, and magnesium lime. "Seven-top" turnips were grown, and dry weights of the top and roots measured at harvest. Calcium lime and magnesium lime, but not magnesium sulphate, caused a significant increase in top growth over the control. There was no significant difference between top weight of turnips from calcium lime and magnesium lime plots or between magnesium sulphate and control plots. Root growth was the same with all treatments and controls. Obviously, the lime, and not the magnesium, caused improved growth of foliage.

L. P. Latimer, G. P. Percival

Winter Injury to Deciduous Fruits

Thermocouples were installed in different parts of apple and peach trees, and temperature studies were made over a three-month period during the winter of 1943-44. Temperatures as high as 86°F were recorded in the cambium on the south side of peach tree trunks, and those in the south sides of apple tree trunks frequently rose to 60°F on clear days even though the air temperature was below 32°F. This amounted to a difference of from 50° to 55°F on opposite sides of peach tree trunks, and from 30° to 35°F in apple trees. By painting the trunks of half the trees white the differences in temperature were reduced to not more thanz 10°F in the case of both peach and apple.

Preliminary experiments on cabbage indicate that it might be possible to measure the death point in plants due to cold by means of electrical

resistance. At the sub-zero temperatures required to kill peaches the apparatus proved to be inaccurate and unsatisfactory.

R. Eggert, L. P. Latimer

Experiments with Blueberries

Plots were laid out for fertilizer trials with lowbush blueberries using sulphate of ammonia, nitrate of soda, muriate of potash, phosphoric acid, and complete fertilizer of 7-7-7 analysis. Ashes and lime also were applied to other plots in varying concentrations.

Sulphate of ammonia, nitrate of soda, and 7-7-7 fertilizer, applied at the rate of 500 pounds per acre, produced outstanding increases in growth on all plots to which they were applied. Neither acid phosphate nor muriate of potash were beneficial when applied alone.

Neither lime nor wood ashes produced any increase in growth when applied at the rate of 100, 500, 1000, or 2000 pounds per acre.

Additional plots were laid out to study the rate of spread of clons on reclaimed blueberry land. Different treatments, such as burning, sawdust, mulch, and mowing, were employed.

Under New Hampshire conditions, the furrow method of propagation continues to appear to be the most satisfactory. Rhizomes were planted against the landside of narrow furrows, into which the furrow slice was then replaced and packed. Two-year-old plantings have produced solid rows of plants.

Ammonium sulfamate, applied as a weed killer in concentrations of 1/16 pound, 1/8 pound, 1/4 pound, 1/2 pound, and 1 pound per gallon of water, was injurious to blueberries as well as to weeds on all plots.

Bushes of highbush blueberries, which were growing on both well-drained and on wet, non-porous soils, were fertilized in May, 1943 with 300 pounds sulphate of ammonia per acre, and were severely injured during the past winter. The greatest amount of injury was observed on those plots cultivated until July 15. Zero temperatures on December 11, 13, 14, 15, and 16, in the absence of a snow cover, were probably responsible. Soil temperatures during that time went as low as 17°F. The coldest air temperature recorded was -12°F on January 17, 1944. Cultivated plots on a well-drained soil and fertilized with acid phosphate and with a 4-24-8 mixture showed much less injury and blossomed heavily in 1944. Five-year-old plants of Rubel, Rancocas, Jersey, Concord, and Cabot varieties were transferred to the Wingate farm near North Barnstead. There, under conditions favorable to the growth of wild highbush plants, they were planted for later comparison.

R. Eggert, A. R. Hodgdon, A. F. Yeager

Root Stock Studies

Bark grafting a ring of Sougog purple wood apple around common white wood varieties and the reverse shows that all new wood in such a case comes from the bark; hence, this should be a suitable way to provide interstocks.

Florence Crab as well as Virginia seem desirable as a body stock for McIntosh and Cortland apples.

A. F. Yeager

Variety Trials

Among the newer apple varieties worthy of consideration by New Hampshire growers are Prairie Spy and Kendall. In observing the remnants of old orchards in the northern part of New Hampshire, it has been noted that the Peach apple seems to be the most persistent. It is a fairly good-quality early apple, and for that section might well again be propagated and distributed.

Of the relatively new grape varieties Kendaia, Fredonia, and Van Buren are outstanding for winter hardiness, vigor, and production. All of these ripen earlier than Concord, and may be recommended as a worthy substitute for Concord in most areas of New Hampshire. While Buffalo and Brockton are high in quality, they have not thus far withstood New Hampshire winters very well and probably can not be recommended. Of the varieties from the Minnesota Experiment Station, Bluejay, Red Amber, and Moonbeam have proven to be winter hardy, but are not of the best quality. Bluebell has not withstood the winters well at Durham up to the present time.

Among the newer plum varieties, Underwood and Superior have made satisfactory crops of good-quality fruit.

A. F. Yeager, L. P. Latimer

Breeding Work

Hybrids between the native wild (*F. virginiana*) and cultivated varieties of strawberries as well as wild types were highly resistant to winter injury in 1943-44. Cultivated varieties and crosses between them were winter-injured more or less severely at the roots. Some were entirely killed. This came as a result of sub-zero weather without snow cover early in December. Out of several thousand seedlings which have been grown, the number has now been reduced to less than 50 for continued study.

L. P. Latimer

Breeding work with raspberries and blackberries and their relatives is being continued. Crosses have been made between wild thornless blackberries (*Rubus canadensis*) and some of the cultivated types to try to develop hardy blackberries of good quality and without thorns. Successful crosses have also been made between Bakeberry from the Bay of Fundy and Taylor raspberry, also between flowering raspberry (*Rubus odoratus*) and both blackberries and raspberries. Plants of this latter group are more or less sterile. About 1000 raspberry seedlings are being grown for the purpose of producing hardier red raspberries, and, if possible, an early everbearing raspberry which might ripen enough of its crop to be of value.

A. F. Yeager

Selections of especially good wild blueberries of the half-high type have been moved into cultivation, and the crosses between selected wild lowbush blueberries and the better cultivated highbush variety have been made and are now growing. Furthermore, some of the best of the lowbush plants have been marked for testing under propagation on land which it is desired to replant to lowbush blueberries.

A. F. Yeager, W. W. Smith

Crosses have been made between cultivated varieties of peaches and certain seedlings secured from the North Caucasus region of Russia by the United States Department of Agriculture. The object is to secure greater hardiness in peaches.

Hybrids have been made between Amygdalus nana, Siberian Almond, and varieties of almonds from California. The seedlings have thus far appeared hardy, although they have not reached bearing age. A plot of considerable size of butternuts raised from the best trees in this area have been planted and are nearing bearing age.

Crosses have been made between McIntosh and Winter Banana and between Macoun and Northern Spy apples. These young trees are growing. The objective of this work is to obtain high-quality, late winter varieties.

A. F. Yeager, L. P. Latimer

Some crosses have been made between Clapp's Favorite and Conference pear, with the object of producing a later variety which has the good qualities inherent in Clapp's Favorite, namely vigor and heavy annual production.

A. F. Yeager, R. Eggert

INSECT CONTROL

Needs of the war emergency have set the pattern for the research program in the Department of Entomology. The aim has been to produce materials that might help to control insects that damage food crops, or those that attack human beings, and at the same time to accumulate data that will shed light on fundamental facts.

In a study of a long series of synthetic organic compounds, two groups, which give promising toxicity against insects that attack human beings, have been discovered. Optimum members of each group, when dissolved in a household-spray kerosene give exceptional performance against flies and mosquitoes, and thus can help to control pests which not only are annoying but are potential carriers of serious human diseases. In the study of these two groups of chemicals many homologues were examined. Information, indicating the molecular configuration which contributes toxicity, was secured. One member of each group is more potent as a toxicant than is to the standard pyrethrum extract.

A technique was devised for observing the "knockdown" performance of new chemical compounds — or, in other words, the ability of a spray to cause paralysis of the house flies used as biological indicators. An enclosure which has glass sides and thus permits unobstructed observation is utilized. The liquid under study is atomized in measured amounts through an orifice in the bottom of the enclosure. Flies are introduced through an opening in the top. The length of time required for partial and for complete knockdown is recorded.

The new chemical compound designated as D D T (dichlor diphenyl trichlorethane) was given intensive study. Many formulations involving this chemical were devised and tested. These included both liquids and dusts. Satisfactory solvents for incorporation of the chemical in a liquid

concentrate were determined, as well as advantageous inerts for compounding dust concentrates. The results of these investigations were incorporated in selected formulae which then became the basis for distribution of supplies of the new compound to other experiment stations throughout the country. Since only limited amounts of the new compound are available (because supplies of it in large quantity are needed for the Armed Forces) the procedure followed avoided unnecessary duplication of effort.

Applications of a contact insecticide by means of an "aerosol" were studied extensively. In an aerosol the insecticide, in the form of a non-volatile liquid, is dissolved in a liquefied gas which is confined under pressure in a small metal cylinder. Release of the contents through an appropriate orifice results in vaporization of the liquefied gas containing the toxicant, and thus breaks up the non-volatile insecticide into extremely small particles which float in the air. Distribution of the toxic particles is rapid and complete, and performance of the toxicant is highly effective.

A special room for study of aerosols was arranged. Walls and ceiling were given a coat of enamel which could be washed down with a solvent. With the room darkened, a beam of light discloses distribution of floating droplets through reflection of light from very minute particles which otherwise would be invisible. It was found that insects could be confined in cages in the room and would react normally to the floating particles when a current of air was delivered through the cages. This technique was thoroughly tested in many replicated experiments.

Utilizing this plan, many formulae were studied. These included the new chemical D D T, dissolved in an appropriate solvent. Experiments proved that the non-volatile contents of an aerosol might be increased to 20 per cent or more, as compared with the 10 per cent hitherto considered an upper limit. Thus, a given container would have twice the effective capacity.

Aerosol containers are being supplied in very large quantities to the Armed Forces. Samples from the production lines of the principal manufacturer are submitted from time to time to this department for biologic test, as a check-up on efficiency.

Since dust applications on plants and on insects may be quickly removed by rain, the addition of a tenacity agent to a dust is important. In the same way insoluble materials suspended in water and applied as a spray are likely to show greatly increased efficiency if the deposit on plants or insects can withstand subsequent rain. Many proposed tenacity agents have been tried by various experimenters. A new material which the department has helped to develop is giving results superior to those shown by any other material hitherto proposed.

The new compound is water-soluble but is sensitive to light. On exposure to a moderate amount of daylight it becomes completely insoluble in water. Addition of the new combination to a typical insecticide dust at the rate of 4 per cent or less by weight renders the dust highly resistant to subsequent rain, providing the application is made when the plants are wet with dew. The same new compound has an important bearing on fungicides which are not tenacious on foliage. Thus, such a material as basic copper sulphate, which has little tenacity, adheres strongly to foliage when

the new compound is added to the spray tank in proportions as little as 2 pounds in 100 gallons of water.

In experiments looking toward control of the apple maggot phenothiazine was compared with standard lead arsenate spray. Control was neither better nor worse.

The spruce budworm was the subject of extensive scouting in the northern part of New Hampshire, through co-operation with the State Forestry Department. It has not yet been found in New Hampshire, though present not far away, in Canada.

W. C. O'Kane, J. G. Conklin, L. C. Glover, W. J. Morse

ORNAMENTALS

The Growth of Gerbera in the Greenhouse

The plants treated with various fertilizers during the previous winter were placed outdoors all summer. In the fall, they were returned to the greenhouse and divided into three groups of seven plants each, and each plant in one of these groups was given one of the following treatments:

N as NH_4	N as NO_3	8-16-16 Commercial fertilizer
5 gm. $(NH_4)_2 SO_4$	5 gm. $NaNO_3$	20 gm.
5 gm. Na tetraphosphate	5 gm. Ca superphosphate	
5 gm. K C_1	5 gm. K C_1	
5 gm. $CaCO_3$		
5 gm. $MgSO_4$		

These treatments were repeated at monthly intervals. The plants all grew vigorously and produced a good yield of blooms. The total numbers of blooms for each treatment from November 1, 1943 to April 7, 1944 were as follows: N as NH_4, 144; N as $NaNO_3$, 116; Complete 145.

From this it appears that no one of these treatments showed any particular advantage over any other. It is noteworthy, however, that ammonium as a source of N is as good or a little better than nitrate. It further demonstrates the value of pot culture for this species.

For tests of soil pH and growth temperature, the plants were removed from beds and placed each in a large porous pot. There was no significant difference in the number of saleable blooms for different levels of pH. At 60°F. night temperature, liming increased the incidence of crown rot, and mites and other pests were much more troublesome than at 50°F. The production, however, was significantly greater at the higher temperature.

S. Dunn, W. D. Holley

Carnation Variety Trials

Twenty-nine varieties of carnations were tested during the past season and the number of rooted cuttings and quality of blooms were noted as well as production records.

Plants were propagated from December through February, and grown in flats indoors until April 15, then in cold frames until they were benched during the first week of June. The flatted plants received a light applica-

tion of sodium nitrate about mid-May, and as a result the plants were of good color and growth at benching time.

A new compost with medium organic matter content was used as soil. Five pounds of superphosphate per 100 square feet of bench was mixed in the soil. At benching time the soil tested as follows: nitrate very high or 50 *ppm.* (parts per million), phosphorus high or 100 *ppm.*, potassium very high or 250 *ppm.*, calcium very high or 2000 *ppm.*, and pH 5.95. When tested again in October, the results were similar, but in February, the nitrate tested low or 5 *ppm.* and pH and calcium were declining slightly. The first fertilizer was applied on February 29 in the form of sodium nitrate and at the rate of 1½ pounds per 100 square feet of bench area. A similar feeding was applied on April 10. Several florists observed these carnations on April 27, and agreed that quality and general appearance were very good.

Production records ended May 31, except for nine selected varieties which are being cut through the present summer in order to determine their response to summer temperatures. If they withstand the summer, they will be cropped another year without being cut back.

W. D. Holley, J. Macfarlane

Soil Management Experiments on Snapdragons

From 1941 to 1944 various soils and soil mixtures were tried for snapdragons. The treatments were designed to determine the comparative value of new compost versus old greenhouse soils and to determine the effect on quality of flowers and total production when additional manure, cinders, or sand are incorporated in the soil.

The compost soil tested medium to high in organic matter and high in all nutrients at the time crops were benched. The pH of these soils ranged from 5.80 to 6.70 but the available calcium was high. The old soils used were of medium humus content containing little unrotted organic matter. Cinders used in this work to give additional drainage and soil porosity were from ordinary soft coal slag that had been screened through a ¾-inch mesh and then the ashes and particles washed out through a ¼-inch mesh.

Nutrient levels, with the exception of nitrates, remained at a high level throughout each crop year. Nitrates were high or at about 30 to 50 *ppm.* in soils at benching time each year and gradually decreased as crops were cut.

When new compost or compost and manure were used, no additional nitrate was needed. In most of the old soils at least one feeding with sodium nitrate was necessary in early spring.

Conclusions from crop records of three years follow:

1. There is no significant difference in quality or production between old greenhouse soils and new compost if similar nutrient levels are maintained.

2. The addition of manure to old or new soil is not beneficial when nutrient levels are kept up by chemical fertilizers. Three of six replications produced less than the control plots.

3. The addition of gravel or cinders (¼-inch mesh) gives no consistent increase in either production or quality. Since the soils used were

fairly high in organic matter this additional aeration was apparently not necessary.

Timing information indicates that early benching is important for early winter production.

The optimum spacing distance for snapdragons is approximately 8 x 8 inches. This might mean a difference of a good many dollars to a grower, especially if he ships or sells at wholesale.

W. D. Holley, J. Macfarlane

Hardiness of Ornamentals

The winter of 1943-44 proved a good test for hardiness of perennials. Several days of sub-zero weather in December without a snow cover apparently caused an unusual amount of winter injury. Complete notes were taken in June, 1944, on the amount of winter injury to plants in the test gardens. Those plants with slight winter injury will recover this season while those with severe injury will take longer and may be so weakened as to be killed during the winter of 1944-45.

Korean Box is proving useful as a low hedge plant. It is an evergreen and is quite hardy.

W. D. Holley, A. F. Yeager

Flower Breeding

1. Chrysanthemum

Two new varieties of chrysanthemums developed especially for pot plant culture will be introduced by commercial propagators in 1945. Granite State, a dwarf white, is especially outstanding and is proving valuable as a parent in further work. This variety came as a selection from an F_2 population from the cross Silver Sheen x White Doty, Chocorua, the other member of the pair, is a bronze "mum" that flowers about October 25.

Two hardy chrysanthemums have been developed to fill a need for early blooming varieties suitable for commercial flower production out-of-doors and will also be introduced in 1945. Nashua, a long-stemmed, red bronze, pompon type, and Sunapee, a gold pompon are both exceptionally hardy. Neither of these varieties was injured during the test winter of 1943-44 when three-fourths of all commercial chrysanthemum varieties were killed in the test gardens. Names peculiar to New Hampshire are being used to designate these new varieties.

2. Carnation

With the purpose of eventual production of carnations from hybrid seed a number of carnation lines have been selfed for from three to four of the five to eight generations required to purify them. When these pure lines are obtained they will then be used as parents for producing uniform hybrid seed. This propagation of carnations from hybrid seed could go a long way in eliminating disease and insect troubles and in giving vigorous and healthy plants.

Occasional seedlings of merit are coming from this work. The most promising variety to date has been a maroon-purple which is long-stemmed, vigorous, an excellent novelty color, and has a well-formed bloom that is

long lasting. Production records on this seedling variety indicate that it will be profitable commercially and it is therefore being disseminated to commercial propagators during 1944 and 1945 under the name of James Macfarlane.

Some promising hybrids have been obtained from a cross of *Dianthus plumarius* with the greenhouse carnation, *Dianthus caryophyllus*. These hybrids are all hardy and at least some of them are fertile. One selection that tends toward perpetual flowering has been self pollenated and an F_2 population is now being grown. Backcrosses between this selection and other carnation varieties have just been made. From some of the generations now growing, or from later ones, it is hoped to get hardy carnations that will flower in the garden from May to November.

3. Saintpaulia

To obtain more desirable sorts of this excellent houseplant, crosses have been made between some of the better existing varieties. Two selections from a cross of *Saintpaulia ionantha* with Blue Boy are being increased for testing purposes. These are dark-foliaged forms that seem to have some resistance to ring spot, a common trouble of the African-violet. These selections have been named Sapphire and Topaz and are now being disseminated to commercial propagators for more extensive testing.

Selections from a cross of Pink Beauty with Blue Boy have been backcrossed to Pink Beauty and should give interesting plants with pink or reddish-colored flowers. This work is slow; 12 to 15 months are required to flower plants from seed and four to five months for seed to ripen after a cross is made. All the known commercial varieties of Saintpaulia, six in number, are being grown at this Station for comparison.

4. Kalanchoe

Many species of Kalanchoe are in use as houseplants throughout the country. This genus of succulent plants and other similar ones from South Africa and Madagascar are easy to grow but little improvement has been done on them. An attempt to improve this group of plants was started in 1938 and some 10 or 12 interspecific hybrids have been obtained. These hybrids are often self sterile and intersterile with other hybrids or species. Occasionally, a seedling or two result from a mass of chaff, indicating that even though the genetic make-up of the hybrid is jumbled, the chromosomes in the sex cells may, on rare occasions, arrange themselves properly and fertilization results. These occasional seedlings are almost invariably fertile and come true from seed, further substantiating the above hypothesis.

Seed of one of these fertile F_2 plants from a cross of *Kalanchoe Blossfeldiana* and *K. flammea* is now being disseminated for testing by commercial seedsmen. This variety has large flowers, garnet-red in color, with leaves almost scarlet in color when the plants are grown under dry conditions. The largest number of F_2 populations heretofore obtained in this breeding work will be flowered during the winter of 1944-45.

5. Begonia

Breeding work has been carried on for the past three years in order to obtain more desirable forms of Begonia, another of the leading houseplants. Double-flowered varieties of *Begonia semperflorens* have been ob-

tained in colors from pure white though various shades of pink to scarlet and with various growth habits.

All graduations of doubleness result in F_2 generations from crosses between single and double. The genetic factors causing doubleness and flower color are quite complicated, following no known Mendelian pattern. Work has been under way during the past two years to determine the method of inheritance of these two factors.

Colored foliage, another factor under observation, has been crossed on double-flowered, green-foliaged plants and the first generation all have single flowers and colored foliage. The F_2 generation should give interesting new types with double flowers in several colors and with colored foliage.

Hybrid seed production is an interesting sidelight to this work. Since double-flowered plants do not produce pollen, it is necessary to pollenate them by hand with pollen from other types. By selection and tests we have double and semi-double parents that, when crossed, produce plants (70 to 80 per cent) with double flowers. The semi-double parent must be selected carefully because some semi-doubles do not carry the factor for full doubleness. The number of petals in the semi-doubles is no guide in their selection because some of the near-single selections carry a high percentage of the full double factor.

W. D. Holley, J. Macfarlane

Lily of-the-Valley

Plantings of three strains of lily-of-the-valley were made in April, 1942 for the purpose of determining the possibility of producing lily-of-the-valley of a quality suitable for forcing. Various fertilizer treatments were made and other cultural practices worked out. Plantings were harvested, graded, and 3-year pips were forced during the winter of 1943-44.

The following conclusions may be drawn from results of this work:

1. Lily-of-the-valley of high forcing quality can be grown in a soil and climate such as southeastern New Hampshire.
2. Fertile, well-drained soil such as that used for intensive vegetable growing is suitable for lily-of-the-valley.
3. Blooms from the pips grown in this experiment were mostly of the two highest grades; namely select and extra-select.
4. The selection of proper strains is of great importance. The yield of salable flowers from the best strain grown was about 97 per cent of the pips planted, as compared to about 80 per cent for the expected average of pre-war, European-grown pips.

W. D. Holley

PASTURES

Pasture Management Studies

Pasture management work involves co-operation with individual farmers.

Work on 12 of the original 19 farms has been continued. Four new farms have been added and work on six of the original farms and the four new ones has been expanded to include plans for the roughage production

program. On seven farms 26½ acres had brush removed and lime and superphosphate applied in the fall of 1943. Two of these farmers have now increased their improved pasture to the point where no supplementary hay feeding is necessary during late summer. In one case the whole roughage program needs reorganization, and, although the owner is still buying hay, pasture is nearly adequate when supplemented by a pasturing-off of second crop of hay in several fields. In another instance, the farmer has cleared six acres of pasture and now has adequate pasture for his present herd. Some expansion, which will require getting better production from some of the pasture area cleared eight years ago, is planned. On still another farm the bush-and-bog harrow was used on four acres of rough pasture and this was reseeded to a pasture mixture.

Original clearing has demonstrated the feasibility of such procedure, and several of the farms have cleared all suitable pasture. The next step, already taken by some, is further improvement of a number of these cleared areas by plowing, harrowing, and seeding.

As pasture needs are met, some expansion in herds is possible and then the whole roughage program must be reorganized. Such plans are now in process on seven farms.

M. F. Abell

Pasture Species

The testing work in 1943 dealt with strains of uniform nursery material as well as with certain native selection, and involved 57 strains of timothy, 11 of Kentucky Blue grass, eight of smooth brome, seven each of Meadow and Tall Meadow fescue, orchard grass and red fescue, four of bent and three of meadow foxtail.

Seed was sown in rod rows and harvested twice, once in late June, and again in early September.

The highest yields were obtained from meadow and tall meadow fescue. This species was followed in turn by Orchard grass, bent grass, smooth brome grass, red fescue, timothy, and, finally, by Kentucky Blue grass. (No yields were available for Meadow foxtail.) Greater differences in total yield appeared among the second cuttings than the first.

L. J. Higgins, P. T. Blood, F. S. Prince

The Improvement of Ladino Clover, Red Clover, And Timothy by Selection and Breeding

A. Ladino Clover

In the winter and spring of 1943, plants selected from the F_2 generation were back crossed to Ladino plants secured from established stands. From these crosses 600 seedlings, representing about 30 families, were produced and set at Greenland. Seedlings were also produced from seed collected from caged plants in the summer of 1942. Twenty-five seedlings from each of 16 mother plants were set in our nursery in May and June. Plantings were scored in September and the best breeding stock determined. Twenty-four plants, representing Ladino parentage, F_1, F_2, and F_3 generations as well as caged progeny, were selected. All of these were brought into the greenhouse for multiplication. Nine of the best will be

used as the basis of a new strain, but all 20 will be tested for yield, and their ability to compete with the grasses, and to persist under definite systems of management. By means of this testing process, we may be able to make further improvements in the strains during succeeding years.

B. Red Clover

Twenty-four seedlings have been brought into the greenhouse for crossing this winter. These seedlings represent the more persistent families of the original lot of 12 which were seeded in 1939 and have stood in the field through four full seasons. They also include some of the plants from the F_1, and F_2 generations produced by intercrossing.

Seed was harvested in the summer of 1943 from the remaining plants from the 1939 seeding. This will be used again for multiplication and testing. Seed was produced in 1943 from the first planting sown in 1942, and some of this seed is available for testing, both in controlled work and on farms.

C. Timothy

Two strains of timothy, one late hay type and one showing certain characteristics suited to grazing, are being carried along. These originally were propagated clonally from parent material in the nursery. The clonal rows are still intact although a few less desirable ones are being eliminated as the work progresses.

Multiplication plots of each were seeded in 1943 for purposes of seed production. Bulked seed was used. In addition, seed of each plant was planted in small duplicate plots for purposes of testing, both for yield records and for persistence under clipping.

F. S. Prince, L. J. Higgins, P. T. Blood

Eradication of Common Buttercup *(Ranunculus acris)* From Permanent Pastures

A number of plots 10 feet square were laid out in each of three buttercup-infested pastures in Durham, West Claremont, and North Haverhill. Three methods of destroying the buttercup were employed: (1) cutting, (2) application of fertilizers, and (3) chemical herbicides. Cutting seemed to offer little promise of an effective control and therefore was discontinued at midsummer. Heavy applications of ammonium sulphate and nitrate of soda stimulated buttercups, and other weeds as well as grasses. The results were considered to be of no value and therefore these treatments were likewise abandoned.

The herbicide sinox, which has had spectacular success in destroying annual weeds in grain fields and flax fields, was tried extensively but with limited success. In North Haverhill, West Claremont, and Durham, plots were treated with sinox of various concentrations, including that recommended for general effective weed killing. Ammonium sulphate was added as an activator. Sinox is a potent contact killer but in every instance the underground parts of the buttercup survived one application.

Borax was applied at a wide range of concentrations and at several different dates in each of the three areas studied. Some success was obtained at North Haverhill in middle and late June with concentrations

ranging from one to four pounds, when the plots were ungrazed. The buttercup at maturity is somewhat less tolerant of heavy concentrations of borax than most grasses. Clovers were destroyed as well as the buttercup.

Ammonium sulphamate seemed to hold the best promise for eventually destroying buttercups without permanent injury to grasses and clover. At North Haverhill, in early and mid-June, applications of 3/16, 3/8, and 3/4 pounds, each dissolved in one gallon of water and sprayed to cover the foliage within 100 square feet of area, made effective kill of the buttercup and at the concentration of 3/16 pound per gallon had no harmful effect on grasses. The Ladino clover was injured somewhat. The area at North Haverhill was ungrazed throughout the summer and fall of 1943 and during the spring of 1944. At Durham, in June and early July, plots were treated with varying concentrations of ammonium sulfamate both under grazed and ungrazed conditions. The most effective treatment was obtained with a concentration of 3/16 pound of the sulfamate per gallon of water, applied to a grazed portion of the pasture. The results were very evident in the spring of 1944 on one particular plot. A decline was noted in number of medium and large-sized buttercups from 30 before treatment in 1943 to 4 or 5 in 1944. Other weeds were destroyed, the grasses were apparently stimulated and the area had been extensively grazed. Adjacent areas left as check plots were ungrazed; grasses were scarce and weeds and buttercups, in particular, were dominant. In the treated plot, clovers apparently had been partly destroyed but were reproducing actively in June, 1944 by seedlings.

A. R. Hodgdon

PLANT PATHOLOGY

Developing Disease Resistance in Early Tomatoes

I. Early Blight Control by Spraying

Tomato plants of the New Hampshire Victor variety were set in the field on June 5, 1943, and were sprayed eight times during the period, July 16 to September 9, with the following fungicides:

Bordeaux mixture 8-4-100
Copper oxychloride-sulphate 6-100
Neutral copper fungicides 5-100
Fermate (ferric-dimethyl-dithiocarbamate)
2-100 plus DuPont sticker spreader (8 drops per gallon)

Five plants were used in each of the treatments and the check. The plants were arranged in a Latin square and the fungicides applied with a knapsack sprayer. The ripe fruits were picked, weighed, and counted at weekly intervals and the incidence of defoliation recorded. Early blight was first found on July 13. At the end of the season, almost complete defoliation of the treated plants as well as the check plants had occurred.

A decrease in the numbers of fruits set on the plants in the Bordeaux treatment was obtained but this injury was partly compensated for in that the fruits produced on these plants were larger. With the exception of the Fermate-treated plants, there were no significant differences found when

the mean ripe yields, total yields, and dry weights of the plants in the treatments were compared with the check plants at the end of the season. In general, the fruit quality decreased rapidly after the plants showed about 80 per cent defoliation. When the marketable fruits produced by the check plants were compared with those obtained from the treated plants—up to the time when the plants showed 80 per cent defoliation—it was found that a significant increase in yields had been obtained as a result of the treatment.

On the basis of the data taken this year, it is believed that when tomatoes of the determinate type are grown, a fairly accurate interpretation of the values of spray treatments may be obtained by comparing cumulative yields up to the 80 per cent defoliation level rather than waiting until the end of the season to compare green fruit yields, ripe fruit yields, or total fruit production.

II. Testing Tomato Varieties for Resistance to Late Blight

In searching for a tomato variety resistant to the late blight pathogen *Phytophthora infestans,* a great many commercial varieties, selections, and species of the *genus Lycopersicon* have been tested. Selections in the species *L. esculentum, L. pimpinellifolium, L. chilense, L. peruvianum* have proved very susceptible. A few selections in *L. hirsutum* have shown some resistance to *P. infestans* with potato tubers as the source of the inoculum.

III. Factors Affecting the Development of Early Blight on Tomatoes

Differences in defoliation from Early Blight among varieties of tomatoes have been observed and studies have been made to determine the factors causing such differences. The relationship between fruit load (the ratio of fruit to leaves) and defoliation was investigated. Sixteen varieties were chosen to represent extremes in tomato types. Ten plants were used from each variety and replicated in a randomized block. The plants were harvested about midseason and the percentage defoliation and fruit-to-leaf ratio was calculated. The results show the fruit-to-leaf ratio is significantly related (at the 1 per cent level) to percentage defoliation regardless of variety. In a second experiment the onset of fruit load in four varieties—Early Chatham, Earliana, New Hampshire Victor, and Marglobe—with respect to defoliation was investigated. Fifty plants from each variety were used and 10 plants from each were sampled weekly. Defoliation was recorded and the fruit-to-leaf ratio calculated. A curvilinear relationship was found to exist between fruit load and defoliation for each variety. The time of fruit yield and the fruit load were found to affect the physiological maturity of the tomato plant. The maturity brought about largely by these two factors vitally affects the time and rate of defoliation of the tomato plant from Early Blight.

M. C. Richards, R. W. Barratt

Spraying for Apple Scab

Spray tests on McIntosh trees were conducted at the University Horticultural Farm. Seven spray applications were made as follows: pink, bloom, calyx, and four cover sprays. Fermate (1½-100) and Mike sulphur (6.6-100) were compared. In a third treatment, Bordeaux mixture

3-20-50 was applied to certain trees in the third and fourth cover sprays on which Mike sulphur had been tested. Lead was added (3-100) plus lime (3-100) to all spray applications, except that made during full bloom.

Results of Spray Treatments for Scab Control

	Mike	Fermate	Bordeaux Mixture
Number of scab spots per leaf	7.47	6.21	2.39
Percentage apples showing scab	4.80	3.61	3.24
Percentage apples showing slight or severe russeting	2.00	7.12	4.23

M. C. Richards

Bacterial Ring Rot of Potatoes

Green Mountain potato plants growing in soil previously infested with the bacterial ring rot pathogen did not develop symptoms of ring rot. Tubers taken from these plants were further tested by planting them in the greenhouse and again ring rot failed to develop. Infected check plants growing nearby showed typical symptoms. Because infection did not occur when the plants were grown in infected soil, it is believed that the ring rot pathogen either does not overwinter in the soil or that infested soil does not serve as a source of inoculum under field conditions in central New Hampshire.

M. C. Richards, H. R. Barratt

POULTRY

Protein Requirements of Chickens at Various Stages of Growth and Development

As a result of the war emergency and the shortage of animal and marine proteins, increased emphasis has been placed upon vegetable proteins as protein supplements in poultry rations. While some experimental information on the value of all-vegetable-protein rations for growing chicks is available, few experimental data have been obtained on the value of all-vegetable-protein rations for laying pullets. In order to supplement the data previously obtained on proteins for growing chicks, an experiment utilizing an all-vegetable-protein ration for laying pullets has been conducted during the year.

Three pens, each containing 20 pullets of comparable age and sexual development, were started, October 15, 1943. Records of body weight, feed consumption, egg production and mortality were kept by 28-day periods for each type of ration.

The rations used are presented in Table I. They were fed as mash and grain. Scratch grain was fed in the litter twice daily.

The mash fed in Pen VII, referred to as the meat-scrap ration, was composed of approximately equal parts of protein from meat scrap and soybean oil meal. This mash corresponds to the type mixed by many feed

manufacturers previous to the war. The mash fed in Pen VIII, referred to as the soybean meal ration, contained soybean oil meal as the only protein supplement. This mash contained no animal protein of any kind. The mash fed in Pen IX was a commercially mixed laying mash. This mash was mixed in conformity with the Government-Industry program for conservation of animal and marine proteins. According to this program, the mash could contain not more than 2.25 pounds of animal protein per 100 pounds of mixed feed. On the basis of 20 per cent of total protein in the mash, this would be equivalent to 11.25 per cent of the total protein in the form of animal protein.

While results from the vegetable protein ration are somewhat below those obtained from the meat scrap ration it is believed that most producers would consider them satisfactory in view of limitations due to a war-time economy. In addition, the results represent only one test. The relative efficiency of the soybean meal ration was 92.5 per cent for egg production and 104.1 per cent for feed consumption. By bringing together the feed consumption and egg production figures, it required 5.69 pounds of feed to produce a dozen eggs with the meat-scrap ration, and 6.40 pounds of feed per dozen eggs with the soybean ration. On the basis of May, 1944 feed prices and the cost of the rations used, the difference in feed consumed per dozen eggs produced represents an increased feed cost of 1.81 cents per dozen for the soybean meal ration.

Mortality was low and comparable in all pens, the 5 per cent mortality representing the loss of one bird from each group. All mortality was due to the same cause, avian leucosis. Weight maintenance was satisfactory and normal, and all groups reached a maximum weight during January.

The hatchability studies show a considerable difference in favor of the meat-scrap ration. Both rations were calculated to the same nutritive content for vitamins A, D, and riboflavin. It is possible that the meat scrap used was considerably above the average in riboflavin content and thus influenced the results. It is also possible that a choline deficiency may have been present in the soybean meal ration since some evidence indicates that all the choline in soybean oil meal is not available for use by chickens. The relationship of choline to hatchability is unknown.

The results from the commercially mixed ration were considerably below the other two groups. Although this group was similarly managed, several of the birds went out of production in January and production was low during the latter part of January, February, and March.

The last annual report of the Department of Chemistry, co-operating, described the arrangement of a feeding experiment in which vegetable proteins were substituted for animal proteins in the feed of growing chicks. The fecal samples collected have been analyzed and the data studied and compared with that from earlier feeding trials.

The different protein sources and the levels of protein fed in the ration in the last experiment are designated by groups as follows:

Group A - soybean oil meal, 15 per cent level of total protein
Group B - soybean oil meal, 19 per cent level of total protein
Group C - corn gluten meal, 15 per cent level of total protein
Group D - corn gluten meal, 19 per cent level of total protein

The data show that there is relatively little difference in the percentage of uric acid nitrogen in the feces of the various groups. In addition,

approximately 60 per cent of the total nitrogen eliminated is in the form of uric acid nitrogen. Individual birds may vary several per cent from this figure. At present, it is not possible to account for the remainder of the nitrogen present in the feces, although previous work has shown that there is relatively little urea or ammonia nitrogen present.

A higher percentage of uric acid nitrogen was eliminated by the birds consuming corn gluten meal than by those consuming soybean oil meal. When the data are compared with those obtained for chicks while consuming animal proteins (Annual Report 1943, Table III) it will be noted that all vegetable protein percentages are higher than those for animal protein. It will also be noted that growth on the animal-protein rations was superior to the vegetable protein rations and that growth on soybean oil meal was superior to corn gluten meal rations. The higher percentage of uric acid eliminated seems to point to the fact that the nitrogen consumed is utilized for energy rather than for growth. This substantiates the prevailing idea that the amino acid content of vegetable proteins is inferior for growth, but that they can and must be utilized for energy when not incorporated into growing tissues.

R. C. Ringrose, T. B. Charles, S. R. Shimer, H. A. Davis

A Study of the Cause and Prevention of Gizzard Lesions in Chickens

It has been postulated that there is a factor in vitamins A and D feeding oils whic his active in influencing the incidence of gizzard lesions. This theory has been under study during the year.

The standard procedure has been to start comparable groups of 20 to 25 day-old chicks on various dietary regimes. A standard control diet has been used for all groups, differences in the diets being obtained by direct addition rather than upon a replacement basis. Records of growth, feed consumption, and any abnormalities which develop have been recorded. At four weeks of age all chicks are sacrificed and the gizzards are examined for the presence of lesions. The severity of the lesions is determined by visual scoring of the individual gizzards in each group. A group score is then calculated.

Using this procedure, the results indicate that high levels of cod liver oil increase the number and severity of the lesions. In addition, there is a further effect on the gizzard lining in that the lining frequently lacks body and tone. One attempt to concentrate the active factor by separation of cod liver oil into its saponifiable and non-saponifiable fractions was without effect. The results obtained by administration of vitamin E indicate inconclusively, that vitamin E has no effect on the lesions.

Cholic acid has a marked preventative action. This raises the question as to the feed or body precursors of cholic acid.

From the results presented it is obvious that one problem concerns the lack of a standard control ration which will produce a uniform severity of gizzard lesions. Work on this problem has been started.

Another problem concerns the uniformity of visual scoring for the severity of the lesions produced. It is reported that the gizzard lining contains cholic acid. Since the feeding of cholic acid has a marked protective action against the occurrence of lesion, it is possible that a cholic acid determination on the gizzard lining will provide an accurate means of measuring

the results. A chemical method for determining cholic acid has been tried with satisfactory results, and the method is now ready for application to experimental material.

The growth results obtained on the experimental rations show that there is no relation between the incidence and severity of lesions and growth obtained. However, field reports indicate that in many cases of unthriftiness in growing chicks, there is a marked incidence of gizzard lesion. Many cases of lack of proper development are being attributed to gizzard lesions. It appears that at present sufficient information is not available to distinguish between cause and effect under field conditions.

R. C. Ringrose, E. F. Waller, T. B. Charles,
S. R. Shimer, H. A. Davis

Pullorum Investigations

The rate at which Pullorum disease will spread among adult birds by means of pen contact was determined. Fifteen birds, reacting to the agglutination test for Pullorum disease, have been kept in contact with about an equal number of birds which were originally negative. Weekly blood tests were run on all these birds until reactors appeared among the negative group. Monthly tests were continued after this time.

Eight birds have been fed broth cultures of Salmonella Pullorum. These were blood tested every third or fourth day following the feeding. At the end of two weeks they were given a complete cultural examination.

After 52 days of pen contact, two out of the 14 negative birds showed an agglutination titre for Pullorum disease. After 73 days one more reactor appeared. No more consistent reactors were found although some birds gave a weak or questionable reaction on one or two tests. At the tenth month, nine birds of the original 14 negatives were still alive. Three of these are showing a definite blood reaction.

Eight to 10 days following the feeding of Salmonella Pullorum in broth culture, seven of the eight birds first showed a reaction. Upon culture the organism was isolated from six of the seven reactors. Usually only one or two of the eight organs cultured in each bird gave us a positive culture. The spleen was the most consistent.

After 50 weeks of pen contact, 17 of the remaining 21 birds were killed and examined. Eight of these were from the original negative birds and three of the eight had been showing consistently positive agglutination reactions since the seventy-third day. The other five have been consistently negative.

Of the three originally negative birds which developed a positive blood reaction, two showed typically affected ovaries and Salmonella pullorum was isolated from these birds. The other one showed a chronic peritonitis only and the organism was not recovered. Of the five birds which remained negative on blood test throughout the year, one exhibited lesions and the Pullorum organism was recovered from it.

The nine birds of the positive group were all showing an agglutination reaction at the time they were destroyed. Four of these birds contained no lesions and no pathogenic organisms were recovered from them. One bird had a few angular, cheesy ovules but no organisms were re-

covered. The remaining four birds in this group showed typical Pullorum lesions and Salmonella Pullorum was recovered from them.

A. C. Corbett, F. E. Allen, E. F. Waller

Anthelmentics in Poultry

A number of compounds were tested for their ability to remove the common round worms of poultry. Two were found to be very effective when given in the feed or in individual treatment in capsules. These were zinc - nicotine - fluorosilicate compounds supplied by General Chemical Company, of New York, N. Y., and were identified as No. 405 and No. 603. No. 603 is a compound being used extensively as a plant dust in aphid control. It was very effective in removing the large round worm but the therapeutic dose and the toxic dose are too close to be safe. The fluorosilicate was found to be the toxic principle.

These compounds were also tried on sheep but were ineffective against stomach worms.

The compound No. 603 was found to be an excellent delousing agent for birds, cattle, and pigs. When diluted with wetable sulphur it remained on the skin of birds and cattle long enough not only to destroy the mature lice but to kill the young as they hatched.

E. F. Waller

Contagious Indigestion (Bluecomb)

During the spring and summer of 1943 we used the experimental Bluecomb vaccine on five flocks totalling 17,000 birds. These farms had all been infected for from one to five years. One third of the birds in these flocks were inoculated and banded. It was previously observed that inoculated birds would pass the virus in their feces for a time. With this in mind all inoculated birds were placed on one side of the range, trusting that there would not be too much mixing. Due to labor conditions complete segregation seemed impractical. By the time the birds were housed, inoculated birds were present in all range shelters. Therefore, it is assumed that all 17,000 birds were exposed to the virus.

Three of the five flocks had no death loss from Bluecomb disease. Several birds were examined from the fourth flock during the summer and fall and one hen in this group presented lesions grossly typical of Bluecomb. It was not a vaccinated bird. In the fifth flock 13 birds in one shelter sickened with typical symptoms of this disease complex. Five of them died and from one of the sick birds the Bluecomb virus was again isolated. The disease did not spread to the other birds in this shelter or to any of the other approximately 1600 inoculated pullets on this range.

Winter laboratory work was limited to blood studies of inoculated birds, to tissue studies of infected birds, and to the improvement of vaccine production. It was found that if the freshly harvested Chorio-allantoic membranes were quickly frozen at 0°F for 15 minutes, they dried more rapidly and could be ground quicker and finer.

The field work for 1944 is being carried on with a larger number of birds and on more farms. All young birds on the farms are being inocu-

lated instead of one-third of them, as in 1943. As of July 1, 31,000 have been inoculated and this number will probably increase to at least 40,000.

E. F. Waller, R. C. Ringrose, A. C. Corbett

SOILS

Methods for Controlling Erosion on New Hampshire Potato Farms

During 1943, the winter rye cover crop plots at Northwood yielded approximately 13 per cent more potatoes than the non-cover crop plots. The average yield of the potato plots at Northwood was approximately 1.5 times that of the erodible plots at Strafford Ridge

Determination of volume weight, capillary, and non-capillary porosity, total aggregation (by wet sieving and dry sieving) and aggregate stability have been made on core samples taken from the Northwood plots. The data indicate that the structural condition of the plots has continued to deteriorate except in the case of cover crop plots. The average values for the total of water stable aggregates in excess of 0.5 *mm* follows:

Plot	Percentage Aggregates in excess of 0.5 mm			
	1940	1941	1942	1943
No. 2 No cover crop	55.6	54.1	47.4	44.5
No. 3 Winter rye cover crop	51.9	49.1	43.5	45.3

The results to date indicate that in the fourth tillage year, after plowing under an excellent grass hay sod, soil and water losses may remain relatively unimportant when potatoes are grown on a contour. Although soil structure has degraded, the degree of degradation is not yet great enough to contribute to serious erosion. This information will be of considerable significance to farmers who participated in expansion of potato acreage in New Hampshire from 6800 acres, in 1942, to 9200 acres, in 1943, particularly since the increased acreage was derived in great measure from hay land.

L. T. Kardos

The Influence of Soil Texture, Soil Moisture, And Soil Aeration on the Growth of Plants

Work was continued with the same widely differing soil types that were used with potatoes last year; namely, a loamy fine sand, a fine sandy loam, and a clay. Because of lack of labor, freshly sifted soil was not prepared and the tomato and corn plants were grown in the same containers in which potatoes were grown previously. Later, a toxicity developed from the corrosion of the walls of the pails used as containers and subsequent crops were grown in freshly sifted soil and re-waxed pails. In order to restrict the number of variables, only fine sandy loam and clay soils, and coarse and fine fractions were used. Daily weighing of the plants to maintain constant soil moisture was also omitted, the water being applied by hose as needed. In the first series, corn showed considerable fluctuation of yield within the different types. The second crop of corn, which was

grown under better light conditions and without toxic, showed that coarse fractions of the coarse soil had a definite advantage. This is contrary to the results obtained with tomatoes when a greater yield was obtained with clay. This finding, however, is consistent with the general tendencies of corn in sand and water cultures in which the yield differed from that of cabbage, especially with aeration.

Sand and water cultures of cabbage and tomatoes were grown in coarse sand and fine sand with aeration. To some of these were added colloidal clay previously purified by electrodialysis. For cabbage, there was greater yield from the cultures with colloidal clay except in coarse sand. In each case the yields were of this order: greatest with solution only, fine sand next, coarse sand least. The results with tomatoes were similar.

S. Dunn

VEGETABLE PRODUCTION

Factors Affecting the Storage of Squash

Storage is an important phase of winter squash production. Inasmuch as most of the squash are consumed after harvest, it is important to the home gardener as well as to the commercial producer. Many technical aspects are involved and, accordingly, five departments are co-operating in this investigation; namely, Horticulture, Plant Pathology, Entomology, Chemistry, and Home Economics. The metohds of handling and curing the effects of temperature and humidity on keeping qualities, chemical changes, palatability, insects and diseases are all involved. A brief summary of some of the conclusions and recommendations follows:

1. Handle with much care; bruises are a cause of rapid deterioration.
2. Sell oversized squash first; immature squash can be stored but quality is poor.
3. Cut stems close to the squash; this practice is found to reduce disease.
4. Store immediately after harvest; if field piling is necessary, hay is preferable to squash vines for covering.
5. Keep the storage space dry and well ventilated and at a moderate temperature. Black rot and rhizopus are encouraged at high temperatures, while fusarium and alternaria develop at temperatures near freezing; fungicides have not proven beneficial.
6. Home gardeners (and others) should can squash four or five weeks after harvest at which time the sugar content is highest, and after which rapid deterioration occurs.

A. F. Yeager, M. C. Richards, J. G. Conklin, T. G. Phillips, T. Levcowich

Variety Trials in Northern New Hampshire

Because of the differences in climate in northern New Hampshire, compared to that of the mountains, a trial plot has been established near Colebrook on which new varieties from the University of New Hampshire and from other selected sources are compared in order to determine which

are best adapted to that locality. Local strains of beans were also planted and compared with standard varieties. During the summer of 1943, a total of 239 strains were planted. Varieties which appear to be particularly good include Early Chatham Tomato, Sugar and Gold and Spancross Sweet Corn, Wyoming Wonder Peas, Sulfur Dry Beans, Brilliant Horticultural Bean, Stringless Green Pod String Beans, Kentucky Wonder Wax and Italian Pole Beans, White Runner as a Lima bean substitute, Agate Soybean, Early Prolific Summer Spuash, Buttercup Winter Squash, Marketeer Cucumber, and Tender Sweet Carrot. It is realized that further trials are needed before definite conclusions can be made, but it is felt that these results make a fairly astisfactory basis for recommendations as to varieties for the present.

H. C. Clapp

Variety Trials at Durham

Variety trials at Durham are limited to the testing of new varieties in comparison with plants used in breeding work and to the comparing of newer varieties from other localities with those under development at the Agricultural Experiment Station to determine whether or not the work should be continued.

Vegetable Breeding

White Mountain Watermelon, the result of breeding work in Durham, has proven popular. It is a small oval watermelon, about the size of a large muskmelon, and will ripen under favorable conditions in about 65 days from seed. The flesh is red, and it has brown seed and a thin rind. Continued work is being done with this type of melon to produce a strain which will have black seed, red flesh, and fewer seeds than the present White Mountain variety.

Extremely early varieties of muskmelons of high quality are ready for distribution for trial. These are of two types, one of Honey Rock type and another, somewhat earlier, round, thick-fleshed, and particularly characterized by perfect flowers; hence it has the possibility of greater earliness than ordinary varieties.

A. F. Yeager

A single plant selection in a large pepper variety trial plot, in 1941, made from Charter Oak developed by the Connecticut Experiment Station, and inbred and tested for two years out-of-doors, carried through two generations indoors. Under limited testing in the field, it has shown unusual promise in the hands of growers in that it produces good-quality peppers in abundance in years when most other varieties fail to set fruit. It is a medium early variety of the Wonder type. It has been named Merrimack Wonder.

A selection from a California Wonder made tetraploid by seed treatment with colchicine is also being continued. Fruits of this pepper are very large and early, but probably not quite as productive as Merrimack Wonder.

A dwarf early variety of pea is being distributed for testing this year.

The basis of its selection was for comparatively large-sized pods, extreme earliness, and resistance to insects and disease. In some years its performance has been outstanding, whereas in other years it has not proven superior to other varieties.

A limited amount of select foundation stock seed of the Flash variety of horticultural bean is ready for distribution. This variety is somewhat earlier than Brilliant but probably not quite as productive.

A. F. Yeager, J. R. Hepler

Breeding work with Lima beans has included selections supplied by the United States Department of Agriculture from some of their discarded breeding lines used for the development of heat-resistant Lima beans. Our problem here is the opposite, namely, varieties that will develop under cool weather conditions. . Some of the selections are earlier than Henderson's Bush and much more productive. Purification has been done by growing generations in the greenhouse where crosspollination can be better controlled.

W. D. Holley

In tomato breeding two objectives have been kept in mind. One is the development of extremely early varieties for the cooler parts of New Hampshire. Strains resulting from crosses with Early Chatham and with certain South American species which give evidence of extreme earliness are being tested in the variety plots in northern New Hampshire. The other line of breeding is to develop tomatoes containing a high content of Vitamin C, from crosses with *L. peruvianum*. This project is in collaboration with the Department of Agricultural Chemistry which makes the vitamin analysis. Selections have been made which carry a Vitamin C content, three or four times as high as standard varieties. Whether or not it will be possible to get these tomatoes up to standard marketable size and still retain the high vitamin content still remains to be determined. Two specialized types of tomatoes have been named during the year. One is called Window Box and is extremely dwarf, determinate in vine type, and has standard-sized fruit. It is satisfactory for growing in window boxes or for extreme early outdoor production. The plants require only about one foot of space. Another is Tiny Tim, a very small fruited type, capable of being matured in a 5-inch pot for purposes of Christmas decorations, and not recommended for field growing.

A. F. Yeager, H. Purinton

Treatment of Seeds with Hormones and Hormone-like Preparations

Tests of various commercial preparations were continued and compared with pure substances and with untreated seeds in order to determine their effects on seed germination and vigor.

Recent tests on thiourea reported in the literature* have shown some stimulatory effects on dormant lettuce seed, when tested on moist filter paper. It seemed desirable to test its effect on seeds subsequently planted

*Raleigh, G. J. *The germination of dormant lettuce seed.* *Science 98: 538, 1943.*
*Thompson, R. C. and Kosar, W. F. *Stimulation of germination of dormant lettuce seed by sulfur compounds.* *Plant Physiol. 14: 567-573, 1939.*

in soil. Seed was counted, treated, and showed a stimulation with thiourea. However, the untreated seed later germinated a higher percentage on filter paper, and when both lots subsequently were transferred to soil, the lettuce growth from untreated seed was actually more vigorous than that for the treated seeds.

Red Kidney beans were germinated on filter paper in two lots, one untreated and one treated with 0.5 per cent thiourea. These showed some inhibition of growth in the treated seed but nearly the same percentage germination was attained in both lots. Thiourea inhibited mold growth on the seedlings. Tests with tomato seed resulted in 80 per cent germination with untreated water and only 10 per cent when thiourea was added.

Onion seed and lettuce seed treated for 24 hours with 0.5 per cent thiourea and then planted directly in a bed of soil showed no particular difference in percentage germination compared to controls or in subsequent growth, except that the onion seed grew somewhat more slowly at first.

Potato seed pieces were treated with the following dry powders and then planted in soil: Seed-aid, Pree-plant, Rootone, urea, thiourea, and p-chlorophenoxy acetic acid. The first three powders were commercial preparations. The control was earliest to sprout, urea and Seed-aid next, Pree-plant and thiourea next, and Rootone was distinctly inhibitory, and all were killed with p-chlorophenoxy acetic acid.

A large number of corn seeds were treated with the same commercial preparations and with dilute solutions of urea, thiourea, and indolacetic acid; they were then planted along with untreated seeds. All germinated at about the same time and grew with the same vigor.

S. Dunn

NUTRITION — VITAMINS — METABOLISM

Factors Affecting the Nutritive Value of New Hampshire-Grown Fruits and Vegetables

I. The Effects of Quick-freezing on the Vitamin Content of Strawberries

The main objective of this study was to note the effect of quick freezing and storage on the ascorbic acid content of different varieties of strawberries grown in New Hampshire. In carrying out this objective, numerous other studies of factors which might affect the ascorbic acid content of the berries were made. These factors include seasonal variation; holding the berries for 12 and 24 hours at room temperature and for the same length of time under refrigeration; holding sliced berries 24 hours in the refrigerator with and without sugar; freezing with and without sugar; and thawing for 12 hours in the refrigerator versus quick thawing.

Six vaieties, Narcissa, Fairfax, Dresden, Catskill, Pathfinder, and Howard 17 were sampled throughout the harvesting season; but due to weather conditions, the size and condition of the crop was below expectation, making it impossible to carry out all the studies planned on any one variety at every picking. In this study, a total of 75 quarts was used, the

quantities of any one variety ranging from one to 13 quarts per picking. The berries at any one picking varied within the limits of ripeness found in commercial grades.

At the start of the experiment representative berries from a mixed sample were used for moisture and ascorbic acid analyses. Due to the slight differences in maturity normally present, it was found that this type of sampling did not produce desirable checks; hence, a pint of whole berries from the larger mixed sample was blended in a dry Waring blendor and aliquots removed for the determinations. Considerable difficulty was encountered with the moisture determination. Drying in a 100° oven caused visible charring of the samples, and in both the vacuum oven at 65° and the convection oven running at 68-72°, the samples continued to lose weight constantly, even after 70 or 80 hours drying time. After numerous trials, the convection oven was finally operated at 68-72° and the drying time reduced to 20 hours. The ascorbic acid content was determined by the Morrell method, using a Klett-Summerson photoelectric colorimeter.

In all varieties the June-picked berries contained more ascorbic acid than those picked in July, some varieties containing considerably more of the vitamin than others. Seasonal variation was found not to be a constant, but to vary among varieties.

All fresh berries held for periods of 12 and 24 hours at room or refrigeration temperatures lost varying amounts of ascorbic acid. These losses not only varied considerably between varieties picked on the same day, but also within the same variety during the growing season. The intra-varietal variation was as great as 40 per cent (fresh weight basis) in some cases. The apparent per cent loss from holding the fresh berries for 24 hours at room temperatures was highest in Fairfax and Pathfinder, where it approximated 50 per cent (dry weight basis); the lowest was Catskill and Howard 17 approximating 30 per cent; Narcissa and Dresden was about 40 per cent.

In the studies with sliced berries held 24 hours under refrigeration with and without sugar, both samples definitely lost ascorbic acid. Again both inter- and intra-varietal differences were noted, but the per cent losses among varieties were not in the same order as the losses when whole berries were held in a similar manner. The limited data tend to show, however, that the sugared, sliced berries did not lose quite as much of the vitamin as did the unsugared.

When the fresh berries were quickly frozen at a temperature approximately -10°F and held in cold storage at temperatures ranging from 0 to +10°F for periods of two, four, and six months all varieties showed progressive losses. Over a period of 6 months the data showed losses ranging from 54 per cent for Catskill to 100 per cent for Narcissa, but the apparent rate of loss in the two, four, or six-month periods was not consistent among varieties. Varieties that started with a relatively high vitamin content retained at the end of the second month of storage as much of the vitamin as other varieties had when fresh.

In a comparison between samples frozen and samples held at room temperature, the apparent percentage loss in four months of cold storage was practically the same as the loss in holding fresh berries for 24 hours at room temperature.

Frozen samples allowed to thaw for 12 hours in the refrigerator always contained less ascorbic acid than the frozen samples analyzed immediately.

In all studies concerned with holding, whether fresh or frozen, the samples that started with the lower ascorbic acid content held the quantity originally present more tenaciously than the samples with the higher original values.

II. The Effect of Quick-freezing on the Vitamin Content of Red Raspberries

Studies, similar to those of strawberries with the exception of sugar additions, were conducted on red raspberries. Ascorbic acid determinations were run on all samples and carotene determinations were also made on varieties used in freezing studies.

The methods for moisture and ascorbic acid were the same as for strawberries. Carotene was determined by the Moore-Ely method. All analytical samples were taken from the blending of a representative sample (approximately one pint) in a dry Waring blendor.

Sixteen varieties were studied for varietal differences in ascorbic acid content of the fresh berries, samples being analyzed from one to four times during the season. Considerable varietal difference was noted but no pronounced seasonal variation within varieties. Two varieties, Bristol and Oles-Black, contained practically no ascorbic acid. Boysenberry, Marion, Sodus, and one experimental cross, P-94, contained between 10 and 14 *mg.* Tacoma, Ruddy, Sunrise, Marcy, Chief, Indian Summer, Taylor, Viking, and the experimental cross, P-78, contained between 18 and 26 *mg.,* while only one variety, an experimental cross, G-13618, contained as much as 34 *mg.* per 100 gram of fresh weight.

A study of the effect of holding was conducted on Chief, Indian Summer, Taylor, and Viking. There was a slight progressive loss after 12 and 24 hours at room temperature, but refrigeration for the same periods caused no marked changes.

Four varieties—Chief, Indian Summer, Taylor, and Viking—were frozen quickly and held in cold storage for four months under the same conditions as the whole frozen strawberries. All varieties showed changes in their ascorbic-acid content. Two samples of Taylors, one frozen July 26, the other July 28 did not lose proportionate mounts. The first sample started with 22 *mg.* per 100 *gms.* of fresh berries and at the end of four months contained 20 *mg.* The later sample started with 25.5 *mg.* and at the end of the same period contained 19 *mg.* The amounts for the other three varieties covering the same storage period are as follows: Chief, 23 *mg.* to 12 *mg.*; Indian Summer, 21 *mg.* to 17 *mg.*; Viking, 24 *mg.* to 18 *mg.* As can be noted, none of these varieties contained a large amount of ascorbic acid when fresh and did not change much in storage. This small change shows the same tendency as was noted in strawberries, i.e., samples with low original ascorbic-acid cotnent hold a large proportion of that quality very tenaciously.

At the end of the storage periods, 12-hour thawing in the refrigerator produced no marked changes from the analytical results found with the quick-thawed.

In studying the carotene content of the four varieties preserved by freezing, it was found that values for the fresh berries covered a wide range, all varieties being low. It was further noted that the changes over a four-month storage period were not consistent. Taylor, starting with 430 *mg.* per 100 *gms.* fresh weight, contained only .214 *mg.* at the end of four months; Chief changed from .405 *mg.* to .285 *mg.*; Indian Summer from .284 *mg.* to .266 *mg.*; Viking made no appreciable change from its original value of .330 *mg.*

In palatability studies over the season, the Taylor and Viking varieties were generally preferred. The Indian Summer berry at one picking rated very high but at a subsequent picking was rated very low. This berry was also very hard to handle for preserving. Palatability tests on the frozen products indicated that these berries were not desirable in the frozen, unsweetened condition. None of the preserved varieties remained in good shape or retained good color after storage.

III. The Effect of Canning and Quick-freezing on the Vitamin Content of Blueberries

Eighty quarts of low-bush blueberries were obtained from a commercial grower on August 3, arriving at the laboratory 20 hours after picking.

When the berries reached the laboratory, 10 quarts were used immediately for "fresh" analyses, and another 10 quarts were placed in the refrigerator to be analyzed 16 hours later, thus approximating the time the berries would reach retail city trade. The remainder were either canned or frozen and placed in storage for future analyses.

In canning, the usual home procedure was followed. In freezing, the same temperatures as employed with strawberries and raspberries were used. Samples were canned and frozen approximately 30 hours after picking.

Blueberries lost approximately three-fourths of their ascorbic-acid content between the twentieth ("fresh") and thirty-sixth hour after picking. The "fresh" analyses averaged 16 *mg.* per 100 *gms.* fresh weight and 16 hours later the average fell to 4.6 *mg.*

At the end of two months storage there was no difference noted between the canned or frozen samples, one being 5.3, the other 5.4 *mg.* per 100 *gms.* of preserved product. The actual ascorbic acid content of the stored samples was approximately the same as that of the samples held under refrigeration for 36 hours after picking.

Due to difficulties with the storage equipment, whereby the temperatures was not maintained, data secured on the frozen product after the two-month storage period are not representative of desirable storage conditions. Two months later under the varying storage temperatures the frozen samples contained only .8 *mg.* ascorbic acid per 100 *gms.*, and hence no further analyses were made on the frozen berries. After six months of storage the canned samples contained approximately .4 *mg.* of ascorbic acid per 100 *gms.* of preserved product.

Due to the facts as noted above, blueberries will not make a marked contribution to the supply of ascorbic acid in the diet. As for palatability canned blueberries did not retain their flavor during storage. Frozen

berries retained most of their original flavor, but developed a tougher texture.

IV. The Effect of Freezing and Dehydration upon the Carotene Content of Blue Hubbard Squash

This study was planned to determine what happens to the carotene in squash when it is preserved for winter use by freezing and by dehydration. In addition, samples of squash from the same harvest were also kept in cold storage, a more common way of home preservation for winter use. Following various storage periods of all three forms, comparisons were made of the changes in carotene values.

Five Blue Hubbard squashes were selected from a large picking and allowed to ripen for two weeks. The squashes were cut in small pieces and aliquots removed for freezing and drying. For the samples to be frozen, representative pieces from each squash were individually ground in an electric food chopper. The ground samples were steam-blanched, and the effectiveness of the blanching period was determined by the peroxidase test. The squashes were not equally ripe, and varying steaming periods were necessary to inactivate the enzymes. Blanched, chopped samples were frozen at temperatures previously mentioned and stored at 0° to +10°F. Carotene determinations were made immediately after blanching and after six months of storage. The remainder of the squash was pared in very thin slices for dehydrating. The temperature was regulated so as not to exceed 150°F.

Samples of the dehydrated squash were tested for carotene immediately after the dehydration and after four and six months of storage. The remainder of the Blue Hubbard squashes gathered at the one picking were kept in cold storage, and representative samples of the squash were ground and analyzed for carotene after two weeks, approximately three months, and approximately six months of storage.

Fourteen Butternut squashes were handled in the same manner as the Blue Hubbard. Carotene analyses were made at the same intervals.

In the samples analyzed after two weeks' storage, the carotene of the Butternut was much greater on the fresh-weight basis than the Blue Hubbard. However, on the dry weight basis the difference was not very great—Blue Hubbard: 1.870 *mg.* (fresh), 18.015 *mg.* (dry); Butternut: 2.810 *mg.* (fresh), 20.143 *mg.* (dry). Blanching decreased the carotene (fresh-weight basis) in both cases. Loss due to blanching amounted to 15.5 per cent for Blue Hubbard — 15.5 per cent and 19.7 per cent for Butternut. Dehydration of Blue Hubbard squash seemed to further decrease its carotene content. Dehydration of Butternut squash resulted in an apparent increase of carotene, and this higher level was maintained over the storage period. The total loss over the storage period was approximately 33 per cent for Butternut and 20 per cent for Blue Hubbard. However, even after these losses, the dried Butternut product contained 2 ½ times as much carotene as the Blue Hubbard, on either the fresh- or dry-weight basis.

Frozen Blue Hubbard squash, stored six months, contained 1.577 *mg.* (fresh weight basis) carotene per 100 *gms.* or less than 1 per cent variation from the originally blanched sample. Frozen Butternut squash, stored six months, contained 1.490 *mg.* per 100 *gms.* or 33 per cent less than the blanched sample.

Analyses made upon squash kept in cold storage seemed to indicate that carotene is synthesized by the squash under these conditions. In the Butternut squash the change was from 2.6 micrograms per gram to 3.8 micrograms per gram; in the Blue Hubbard squash from 0.9 micrograms per gram to 2.9 micrograms per gram, over a period of approximately five months.

S. R. Shimer, T. Levcowich, H. J. Purinton,
A. E. Teeri, A. F. Yeager

Culinary and Preserving Qualities of Fruits and Vegetables Grown in New Hampshire

The various varieties studied were judged in most cases by a panel of judges, using a score sheet provided for each fruit or vegetable. Nine varieties of early apples were studied. They were compared with each other as fresh applesauce, canned applesauce, and also as dehydrated apples which were prepared as sauce before judging. The varieties tested were as follows: Duchess, Erly McIntosh, Milton, Patten, Red Astrachan, Station 4793, Whitney Crab, and Yellow Transparent. Of these Pattens' Greening, Yellow Transparent, and Whitney Crab ranked highest as fresh applesauce. As canned applesauce the following were judged best: Yellow Transparent, Patten, Milton, and Melba, and as dehydrated applesauce the scoring gave the following as best: McIntosh, Early McIntosh, and Melba.

Among nine varieties of pears, Flemish Beauty produced the best canned product, and Sheldon the poorest. Because of the difficulty in handling pears to secure best quality for eating and preserving, one year's results should not be considered as conclusive.

Seven varieties of grapes were prepared for juice. Fredonia and Van Buren (which are among the most satisfactory varieties to grow) were found to be excellent. Red Amber, a new variety from Minnesota, was not satisfactory for juice.

A new variety of dwarf pea recently developed by the Department of Horticulture was found to give a satisfactory frozen and canned product in comparison with such standard varieties as Thomas Laxton, Greater Progress, and World's Record.

Among nine varieties of sweet corn used for quick freezing, Tendergold had the highest score.

Fourteen varieties of green beans were frozen and compared. All were found to possess satisfactory freezing quality. However, Keystonian ranked slightly highest among the group.

Seven varieties of rutabagas were cooked. Of these a new variety known as Storrs ranked first, with Waltham No. 3 second.

Among ten varieties of carrots Half Long Nantes and Red Cored Chantenay ranked highest as a raw vegetable and scored at or near the top as a cooked product.

The major part of the year's work involved that of cooking and judging the palatability qualities of 74 samples of dried beans which included native-grown beans from various parts of New Hampshire and some of the standard commercial varieties. This investigation was in co-operation with the Department of Horticulture which was conducting a study

to determine the quality of local strains of beans which have been carried in New Hampshire families for many years.

These locally-grown dried beans were cooked under controlled conditions and compared with standard commercial bean varieties, such as White Navy, Red Kidney, Yellow Eye, Michelite, Great Northern, and Robust. For each series of cooking tests a standard sample of Lapin Bean served as a control in judging various characteristics of the bean samples such as color, shape, texture, and flavor. The perfect score for bean samples was 40. The average score results are available in table form, and have been weighed by giving flavor a value of 50 per cent, texture, color 20 per cent each, and shape 10 per cent. Of the 74 samples the three highest scored samples were native grown, namely: Pole Horticulture, Cranberry, and Improved Yellow Eye. The commercially-grown beans ranked below eight of the New Hampshire grown beans. In order of desirability they were: Yellow Eye, Michelite, Red Kidney, Robust, Great Northern, and Lapin, and they were scored within the upper limits and the range was 35.76 - 19.91.

The length of cooking time for the bean samples ranged from 20 minutes to 81 minutes.

T. Levcowich

Nutrition Studies with Lactating Cows

The work done this year includes nine experiments in which the complete ingo and outgo of matter and of energy of lactating cows were measured by means of digestion balances and metabolism experiments. These experiments represented successive stages of lactation, and different levels of production, and they included dry rations and rations in which freshly cut grass was substituted for hay and beet pulp. Simplified low-protein grain mixtures, consisting of cornmeal, wheat bran, and ground oats were used. A record of production was also obtained, while the cows were grazing on inferior pasture supplemented with various amounts of this grain mixture.

One major result indicated the possibility of a more accurate basis, physiologically, of expressing the protein requirements of mature cattle. Another result of critical significance was that when feeding according to standard recommendations the trend has been to supply a material excess of protein and a bare sufficiency, or even a deficit of energy (T.D.N.), when production exceeded 40 pounds of milk per day.

When feeding freshly cut grass (60 to 65 pounds) which was fairly mature (July), it was impossible to supply sufficient energy to maintain a balance. At 40 and 45 pounds production, even with the addition of 12 pounds of grain, the energy deficits were 9024 and 7755 calories, respectively (i.e. 5.1 to 4.8 pounds T.D.N.), although the protein deficits were relatively small.

Grain mixes of low-protein content and consisting of home-grown feeds, such as cornmeal, ground oats, and wheat bran, supply adequate protein for production up to 40 pounds of milk, when they are fed in a ratio of about one pound to four pounds of milk, (provided that about half the roughage consists of good legume hay). At levels of production above 40 pounds of milk per day there was a tendency toward a greater deficit in

energy than in protein. If large energy deficits are to be avoided, midsummer pasturage of relatively mature growth must be supplemented with a liberal allowance of grain when production exceeds 40 pounds of milk.

The results of this series of studies on protein, and requirements of lactating cows are now being prepared for publication. This will report the physiological results of 25 digestion and metabolism balance experiments carried out with seven cows at different stages of lactation, and 46 such experiments with dry cows to determine the requirements of protein and energy for maintenance.

This completes the work concerned with "nutrition studies on the protein and energy requirements of lactating cows." The project is now revised to provide for a study of the "physiological utilization of immature pasture grass by lactating cows." The Department of Agricultural and Biological Chemistry, co-operating, will make the necessary chemical analyses of feed and excreta.

E. G. Ritzman, N. F. Colovos, A. D. Littlehale

Effect of Vitamin A on the Utilization of Energy and Protein by Calves

The work, this year, was carried out with six purebred bull calves which were about four days old when the experimental feeding began. The method of procedure was about the same as during the previous year, two calves being given a deficient Vitamin A intake, two a normal intake, and two an excess intake. The chief difference consisted in supplying the vitamin in the form of carotene instead of cod liver oil concentrate as before, and of supplying the D requirements in form of irradiated yeast. Three digestion balances were carried out on each calf (with the exception of one of the normals) at about 12, 20, and 28 weeks of age. Thirty respiration experiments to determine the total heat production and the basal metabolism also were conducted during this time. Again blood samples were obtained periodically and analyzed for carotene, Vitamin A, ascorbic acid, calcium, and phosphorus.

No final statement on the results obtained can be made at this time as some of the chemical analyses involved have not been completed. However, it may be stated that the calves on the deficient ration (one-twentieth of normal requirement) developed spasms after a relatively short period of deficient Vitamin A intake, but showed no apparent irreparable eye damage as was the case previously when Vitamin A was supplied in the form of cod liver oil.

Intestinal disturbance, poor growth, and defective vision which often result during the early growth stage*, when calves are raised on skim milk and cereal products, can be avoided by feeding even moderate dosages of Vitamin A, either in the form of carotene supplemented with irradiated yeast or with cod liver oil.

This completes the work on Vitamin A, the results of which are now being prepared for publication. A study of Vitamin D will follow immediately.

N. F. Colovos, E. G. Ritzman, H. A. Keener, A. D. Littlehale

**Before calves can properly digest good roughage.*

Metabolism of the Horse

Work was again resumed during the year on the study of fatigue and rate of recovery after exercise (brisk trotting) as a test of relative physical fitness and endurance of the horse. This work was conducted on an 0.85 mile stretch of flat country road. The factors studied were (1) effect of temperature and wind conditions on oxygen consumption, and (2) the effect of enriching the fresh air intake by additional oxygen from a container. Rate of recovery was determined by measuring the oxygen consumption at five-minute intervals after exercise. Five experiments were carried out with a Percheron draft gelding and one with a purebred Morgan stallion.

Oxygen consumption during a brisk trot, and particularly during recovery following exercise, is a more dependable and accurate index of "staying power" than is pulse rate. Oxygen consumption during exercise was not measurably affected by environmental temperature differences of 15° and 21°C. It increased per minute with increase in rate of speed, and the oxygen debt increased fourfold when speed per mile was increased from 5.1 to 4.4 minutes. Enriching the air during exercise with oxygen from a container reduced the time required for recovery without extra oxygen to five minutes as against 15 and 20 minutes when the air was not enriched.

Practical deductions relating to judgment of relative performance (stamina) and also to feeding and management from such data are obviously in prospect, although the work has not progressed with sufficient numbers of animals as yet to arrive at final conclusions.

E. G. Ritzman, N. F. Colovos, A. D. Littlehale

STATE SERVICE

In addition to the active research projects, many Agricultural Experiment Station workers devote much time to performing a direct service to the people of the state. The numerous inquiries received by the administration and distributed to the respective specialists must receive immediate attention. Such inquiries have been particularly numerous during the present war period. Below is a summary of the major services (excluding correspondence) which were carried on during the fiscal year 1943-44.

Inspection of Fertilizers and Feeding Stuffs, and Soil Testing

In accordance with the public statues regulating the sale of commercial fertilizers and of concentrated commercial feedingstuffs, 67 brands of fertilizers and 405 brands of feedingstuffs were analyzed during the year 1943-44. These analyses involved individual determinations totaling 458 and 3175 respectively. In connection with the feedingstuffs inspection a considerable amount of work has been done in collaboration with the Association of American Feed Control Officials on the development of analytical methods for the determination of carotene, riboflavin, and fluorine.

Also, miscellaneous samples of feedingstuffs, fertilizers, and other materials have been analyzed for residents of New Hampshire. During 1943-44, there were 90 samples involving about 225 determinations.

Approximately 700 samples of soils were analyzed for residents of the state, an appreciable decline from the previous year.

T. O. Smith, H. A. Davis, G. P. Percival

Seed Inspection

At the 1942-43 session, the New Hampshire Legislature passed a new seed law. At the time, the former law, passed in 1921, needed either to be revised or to be made over completely and patterned after the "Suggested Uniform State Seed law," which was prepared by the Agricultural Marketing Service of the United States Department of Agriculture in the interest of uniformity and as a guide for the various states in drafting seed laws to conform to the 1939 Federal Seed Act. This act applies only to shipments in interstate commerce and imports and works in conjunction with individual states.

An important aspect of the new state law is the labeling requirement which is more strict than formerly in that the number of noxious weeds must be stated. This provision is to prevent New Hampshire from becoming a dumping ground for seed which cannot be sold in states that have a noxious weed law. (There are only three states which do not have such a law.)

The law also includes requirements about vegetable seeds. Before it was passed, there was no check whatsoever on the quality of vegetable seed sold in the state. Now rules and regulations include germination standards for vegetables, a fact which is very important because the germination expected for different crops varies greatly. For instance, the standard for New Zealand spinach is 40, for pepper 55, for parsnip 60, while for beans, cucumber, lettuce, and peas the standard is 80.

Another requirement of the law is that all agriculutral and vegetable seed shall have been tested for germination within nine months after being offered for sale. This clause eliminates the possibilities of two- five-, or even 10-year old seed being placed on the market.

Last fall, the seed inspector for the State Department of Agriculture made a survey of some of the seed on sale in New Hampshire. This seed was sent in to the laboratory for germination. Some of it was incorrectly labeled and some was worthless.

Dealers found themselves with fairly large stocks of carried-over seed which had to be tested for germination before it could be sold this season. This meant that the dealers had to take samples of these lots and send them in to the seed laboratory. Consequently, since January first, instead of testing official samples taken by the State Seed Inspector to determine whether the seed being offered for sale is in compliance with the new law, 1251 samples have been tested for germination, including 33 lawngrass mixtures. Approximately 40 of these tests were made for farmers who had grown beans or corn and wished to sell them for seed.

During the fall and winter of 1944-45, it is planned to have the samples of carried-over seed sent in during October, November, December, January, and February in order that these tests may be completed if possible by April 1 so that we may start on the official inspection, because by another spring it is reasonable to expect dealers and wholesalers to be fa-

miliar with the new law and to have had opportunity to comply with its requirements.

Rules and regulations relative to the administration of the seed law were drawn up and adopted, and report and record forms were revised to conform to the new law. Referee samples were handled in co-operation with other seed laboratories as in past years. A small amount of work was done as a member of the Public Service Committee of the Association of Official Seed Analysts.

B. G. Sanborn

Potato Seed Certification

Field inspection of the 147.12 acres of potatoes entered for certification in the Colebrook area was carried out in co-operation with the State Department of Agriculture. Two inspections were given during the growing season, and all of the fields were certified.

As provided in the certification rules, early in the winter of 1943-44 the growers submitted samples of tubers from their seed plots for a greenhouse test. A seed piece from each of these tubers was grown at Durham and disease readings taken. Twelves samples were tested. All were within the tolerance allowance.

S. Dunn

Autopsies at Poultry Laboratory

During the fiscal year 1943-44, 3,785 specimens plus 940 milk samples were submitted to the Poultry Laboratory for diagnosis.

A total of 3,513 chickens were examined, 3,243 from commercial poultrymen, and 270 from the university flock. In addition, 158 turkeys and 114 miscellaneous specimens were examined at the laboratory.

A. C. Corbett

Pullorum Testing

During the testing season of 1943-44, the staff of the Poultry Laboratory ran agglutination tests for the detection of pullorum disease on the blood of 1,242,805 hens and related fowl owned by New Hampshire poultrymen. In addition, 64,541 birds were retested, making a total of 1,307,346 samples tested.

The birds tested were from 748 flocks and of this number 26 flocks were found to harbor the infection. The infected flocks had a total of 572 birds affected with pullorum disease. Thus 3.47 per cent of the 748 flocks were found to be infected and .04 per cent of the total number of birds tested were found to carry the pullorum organism.

The number of birds tested for pullorum disease has increased rapidly since the inauguration of the program in 1918-19 when 4,000 birds were tested. In 1925-26, after Pullorum testing had been under way for seven years, there were 35,237 birds tested. Of this group 34 per cent of the flocks were infected and 2.5 per cent of the total number of birds were infected.

From the above figures one can readily see the value of the testing program to the poultrymen of the state in reducing the losses from Pullorum disease. It is true that infection is found each year; but such a condition is inevitable as long as birds and chicks are imported from states which carry a high percentage of infected flocks and as long as untested but infected flocks remain in our own state. Nevertheless, the situation is quite satisfactory and New Hampshire poultrymen enjoy the reputation of having a higher percentage of disease-free birds, as far as Pullorum is concerned, than any other state in the country.

F. E. Allen

Manufacture and Distribution of Fowl Pox Vaccine

During the year 1943-44, 184 poultry flock owners purchased 331,650 doses of fowl-pox vaccine from the University Poultry Laboratory.

This material is produced in a building which is used only to harbor the birds used in its preparation. Such birds must be in a healthy condition as assured by appropriate blood and laboratory tests. The birds are purchased from the University Poultry Farm.

The Univesity holds a Federal license to manufacture this vaccine; accordingly, it must meet certain rigid standards of purity and potency as set up by the United States Department of Agriculture. Because of these standards of purity and potency New Hampshire poultrymen are getting a product which will produce immunity to fowl pox without introducing other disease-producing organisms.

F. E. Allen

Manufacture and Distribution of Fowl Laryngotracheitis Vaccine

During the period of eight months from July, 1943, through February, 1944, a total of 33,900 doses of laryngotracheitis vaccine were manufactured and distributed to several poultrymen in Rockingham, Merrimack, and Strafford counties. Although this service was self-supporting, the manufacture of this vaccine was discontinued on July 1, inasmuch as commercial products are now available.

E. F. Waller

National Poultry Improvement Plan

Record of Performance. During the past year there were 14 flocks of chickens on 11different farms under official supervision. A total of 5436 birds were placed under trap, out of which 2166 females qualified for U. S. Record of Performance. The total hen population of these farms was 54,488 birds. These breeders had 2176 females in their U. S. Record of Performance matings. In addition, one turkey breeder had 200 birds under State Record of Performance supervision.

Certified. Six flocks, involving 16,790 birds, were certified.

Approval. In the U. S. Approval stage of the plan 175 flocks have qualified, involving a total of 348,617 birds.

H. E. Parker, T. B. Charles

Dairy Bacteria and Mastitis Testing

During the year, 1152 samples were tested for bacteria, 91 samples for butterfat, and 11 samples were tested on the Mojonnier for fat and solids.

Babcock glassware calibrated include 481 milk test bottles and 177 pipettes.

Considerable glassware was supplied the D. H. I. A. testers.

H. C. Moore

A total of 324 samples of milk which were submitted by New Hampshire dairymen and veterinarians were tested for evidence of mastitis infection.

L. W. Slanetz

December 8, 1944

Expenditures for the Year Ending June 30, 1944

	Hatch	Adams	Purnell	Bankhead-Jones	Supplementary*
Personal Services	$ 9259.63	$14232.99	$50614.98	$7422.34	$28399.88
Travel	706.30	143.10	1060.06	470.90	1030.86
Transportation of Things	364.34	47.76	78.47	5.04	124.62
Communication Service	457.95	7.60	38.25	20.75	274.07
Rents and Utility Services	700.00	----	364.38	98.00	----
Printing and Binding	325.47	----	305.72	25.40	----
Other Contractual Services	345.37	49.29	1127.66	21.46	283.84
Supplies and Materials	1159.45	376.65	5309.03	220.24	4035.56
Equipment	1681.49	142.61	968.89	223.27	5841.17
Lands and Structures (Contractual	----	----	132.56	----	----
	$15000.00	$15000.00	$60000.00	$8507.40	$39990.00

*This fund includes monies from the following sources:

State Appropriations Bankhead-Jones Offset	$ 8507.40
Miscellaneous Income	26146.95
Federal Sales	5335.65